Safety Assessment in Industrial Construction Projects in Saudi Arabia

by

Mirza Mansoor Baig

A Thesis Presented to the

FACULTY OF THE COLLEGE OF GRADUATE STUDIES

KING FAHD UNIVERSITY OF PETROLEUM & MINERALS

DHAHRAN, SAUDI ARABIA

In Partial Fulfillment of the
Requirements for the Degree of

MASTER OF SCIENCE

In

CONSTRUCTION ENGINEERING AND MANAGEMENT

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عمادة الدراسات العليا
DEANSHIP OF GRADUATE STUDIES

To My Loving

Mother

And

My Late Father

Acknowledgement

All praises are due to Allah, Subhaanahu Wata'aala, for His blessing on me and members of my family. I feel privileged to glorify His name in the sincerest way through this small accomplishment. I seek His mercy, favor, and forgiveness. I ask Him to accept this little effort as an act of worship. May the Peace and Blessings of Allah be upon His Prophet, Muhammad (Salla Allahu Alaehi Was-sallam).

I would like to thank all the members of my committee. My sincere thanks and respect to my advisor Professor Osama A. Jannadi. I am grateful to him for his continuous efforts he puts into his students, to guide them through. It was because of him that this work at any point of time never got stressful. I thank Professor Ishteeaque Ellahi, for his constant assistance and support throughout the researching and writing period.

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Although there is insufficient space to properly identify all of the other persons who have contributed their efforts to this research, I feel that I must identify a few. I wish to express my sincere thanks to Iqbal Bhai, Nadeem, Farooq, Abdul Bari, Mukkaram Bhai, Mohd. Pasha, Mazhar Bhai, Zaki and all my other friends for their constant encouragement, assistance and Duas. I would like to thank Jalal and Raza Bhai for their editorial modifications and moral support throughout this work.

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Abstract (English)

Name : **Mirza Mansoor Baig**

Title : Safety Assessment of industrial Construction Projects in Saudi Arabia

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This study assessed the safety on industrial construction projects in Eastern Province of Saudi Arabia. To assess the physical aspects of safety walkthrough inspections using a checklist were carried out. To address the safety climate and to know the attitude towards safety, questionnaires were developed and used. Safety performance level index (SPLI) for all industries was calculated. For support industries this value varies greatly and the average was 84.0. For secondary group of industries, the SPLI values are mostly consistent, with one exception and the average value was 81.25. The SPLI values for primary industries were also consistent with the average value being 91.48.

Safety level score (SLS) for all industries were calculated and it was found that these values in primary group are high, the average being 0.80 on a scale of 1.0. The SLS values vary greatly in secondary group of industries, the average being 0.61. The SLS values in support industry group were low when compared to primary and secondary and the average was 0.47. With the safety level scores for all industries it could be concluded that, the safety level varies with the size of the industry. The correlation coefficient between the performance level (safety system) and the safety level (physical aspects) for all the industries were calculated and it was concluded that there is no significant association between the performance level and safety level.

Master of Science Degree

KING FAHD UNIVERSITY OF PETROLEUM AND MINERALS

January 2001

Abstract (Arabic)

خلاصة الرسالة

الاســــــــم : مرزا منصــور بيغ

عنوان الرسالة : تقييم الســلامة في مشروعات المنشآت الصناعية بالمملكة العربية الســعودية

الدرجــــــــة : ماجستير العلوم

التخصــــص : إدارة وهندسة التشييد

تقيّم هذه الدراسة السلامة في مشروعات المنشآت الصناعية في المنطقة الشرقية بالمملكة العربية السعودية . لتقييم الجوانب المادية للسلامة تم القيام بفحص ميداني باستخدام قائمة فحص قياسية لدارسة مناخ السلامة وللتعرف على المواقف تجاه السلامة تم استخدام استبيانات صممت لهذا الغرض . تم حساب قيم مستوى أداء السلامة لكل الصناعات . وأستنتج هذه القيم بصورة كبيرة في صناعات الدعم وكانت القيمة المتوسطة ٨٤,٠ أما بالنسبة لمجموعة الصناعات الثانوية فإن قيمتة كانت متوافقة باستثناء حالة واحدة وكانت القيمة المتوسطة له ٨١,٢٥. بالنسبة للصناعات الأولية كانت قيمه مستوى أداء السلامة في معظمها متوافقة بحيث تأخذ في المتوسط القيمة٩١,٤٨ .

لقد تم حسب قيمة مستوى السلامة لكل الصناعات وكانت المجموعة الأساسية عالية بقيمة متوسطة مقدارها ٠,٨ من ١,٠ كحد أعلى للقياس بينما يتباين ذلك بصورة كبيرة لدى مجموعة الصناعات الثانوية بقيمة متوسطة ٠,٦١. ولكن لدى مجموعة صناعات الدعم تنخفض هذه القيم مقارنة بالصناعات الأولية والثانوية حيث كان المتوسط ٠,٤٧ ويمكن استخلاص أن مستوى السلامة يتغير تبعاً لحجم الصّناعة . تم أيضاً قياس معامل الارتباط بين مستوى الأداء (نظام السلامة) ومستوى السلامة (الجوانب العادية) وتبيّن عدم وجود ارتباطاً وثيقاً بين مستوى الأداء ومستوى السلامة .

ماجستير العلوم

جامعة الملك فهد للبترول و المعادن
يناير ٢٠٠١

CHAPTER 1

INTRODUCTION

1.1 Background

Saudi Arabia has become a modern state with a strong economic base, sophisticated infrastructure and large industrial, construction, trade and contracting sectors contributing to overall growth. The construction sector has historically been an important component of the Saudi economy due to its contribution to GDP, employment and investment. Total expenditure in the Saudi construction sector, as measured by the level of gross fixed capital formation, is estimated to have risen by 0.4% to SR 66.8 billion in 1997 and was expected to decline by 10% to SR 60.1 billion in 1998. A further rise of 1% to SR 60.7 billion is expected for 1999 while a robust 3% growth is anticipated for the year 2000. *(The NBC economist, 1998)*

Nearly 52% of the total investment expenditures on construction is concentrated in the area of commercial and industrial buildings estimated at around SR 34.7 billion in

1997, followed by residential buildings at 22% or SR 14.7 billion, and other construction activities at 26% or SR 17.4 billion. *(The NBC economist, 1998)*

Safety has always been a major issue at construction sites. Coping with accidents is costly and time-consuming for the construction personnel. Throughout the industry, construction is one of the most hazardous industries. The major causes of accidents are related to the unique nature of the industry, human behavior, difficult work-site conditions, and poor safety management, which results in unsafe work methods, equipment and procedures. *(Koehn, et al., 1995)*. However, safety is not a luxury and should be considered as an important function to be set against unnecessary loss of property, injury or death. Preventing occupational injuries and illness should be a primary concern of all employers.

Each year a substantial number of construction workers worldwide lose their lives and countless others are injured. Estimates of the number of fatalities range from several hundred to over 2,000 per year. *(Harper & Koehn, 1997)* The number of fatalities is important criterion to compare hazards in construction industry with those in other occupations. Change in this data over time also serves as a measure of trends in construction safety. More important than the total number of construction fatalities is information on the causes of these accidents. It is this type of information that can be used to develop a safety program.

Since the adverse impact of injuries is severe, it is important to take steps to prevent injuries. The common approach is to try to anticipate the source or causes of major injuries. This approach has a clear focus, however the identification of injuries is critical to develop a safety program. The best means available is to examine the causes of past injuries and learn from mistakes. This is possible if a large database of this information is available.

"Safety is no Accident", Safety is up to you", Be Alert –Stay Alive" and "Safety Pays" are few of the common slogans on posters, signs or in magazines whenever men are working in any industry. Frequently, many companies feel that by providing this visual lip service to accident prevention they have viable safety program. Safety must be regarded as a basic component of the management philosophy, just as operating at a profit is, because cost of accidents presents a serious drain of profit. An aggressive company has to examine each of the operations with a keen interest to see not only the work is done in the most efficient manner to ensure greatest potential profit, but that it is done as safely as possible for the very same reason. *(Fern, 1980)*

1.2 Statement of Problem

Preventing occupational injuries and illness should be a primary concern of all companies. There must be an effort to raise the level of awareness among both employee and employers of the importance of health and safety at work sites.

Surveys of the US construction industry show that the majority of contractors annually spend less than $25,000 on safety education. This is a relatively small expenditure. In Saudi Arabia there is urgent need for increased awareness and comprehensive safety program in all the industries and construction industry in particular, as the occupational injuries are on the rise. According to GOSI in Saudi Arabia 146 million Riyals are paid under occupational hazard scheme (OHS) during the financial year

1994 and this amount is increasing steadily and reached 158 million Riyals in 1998. *(GOSI, 1998)*

1.3 Significance of the Study

Accidents in any industry especially in construction tend to be costly in both human and financial terms. As safety is concerned with reducing rates of accidents and controlling or eliminating hazards at the work site, preventing accidents must be the first significant step towards safety improvement. There is need to increase awareness and to exert pressure on companies to safety. Economical, social and governmental regulations are few factors responsible for this increased pressure. Identification and understanding of accident causation is a prerequisite for improving safety.

completed sequence of factors the last one of these being the accident itself. The accident is in turn invariably caused or permitted directly by the unsafe act of a person and/or a mechanical or physical hazard (i.e. unsafe condition). To avoid accidents it is required to identify and eliminate unsafe acts and unsafe condition, which could be achieved by regular assessment of safety on site, employee training and inspection.

This study aims at assessing the safety condition including physical and safety climate of industrial construction projects in Saudi Arabia. It will have substantial impact and will benefit the construction industry in particular and all industries at large. This study will help in increasing awareness and in identifying areas of deficiencies in industrial safety.

1.4 Objectives of Research

The objective of this research is divided into four subgroups, which are as follows:

1. To assess the safety level of industrial construction projects in the Eastern Province of Saudi Arabia.

2. To assess the performance level & safety level.

3. To correlate the safety climate & physical aspects.

4. To provide information for further consideration related to safety by means of conclusions and recommendations.

1.5 Scope and Limitations of the Research

Three aspects, the physical condition, safety system and psychological factors affect safety performance on industrial projects. The unsafe conditions on workplace constitute the physical aspects of safety. Safety system consists of the perceptions and attitude of the management, safety professionals and all other employees. The behavioral aspect of the

physical condition and the safety system aspects.

Industrial construction projects in Eastern Province of Saudi Arabia were covered in this study. The geographic coverage was limited to major center of industrial activity, Jubail in Eastern Province of Saudi Arabia. Jubail industrial city is the biggest industrial city of the kingdom and it is representative of the Saudi Arabian industry. These restrictions are due to lack of time to collect the required data & vast number of projects of industrial type.

CHAPTER 2

LITERATURE REVIEW

2.1 Safety Definition

Safety can be considered as commonsense approach to removing agents of injury. The dictionary meaning of the word safety is " the conditions of being safe from undergoing or causing hurt, injury or loss".

2.2 History of Safety

There was no significant progress in industrial safety before 1911 and was practically nonexistent. With lack of worker's compensation laws, people handled industrial injuries under the common law, under which the legal defense available to the management of the industry almost ensured that they would not have to pay for any accidents occurring on the job. Under this common law system employee did not automatically receive payments when injured on the job, as they do today. (Petersen, 1971) In Saudi Arabia, the General Organization for Social Insurance (GOSI) started functioning in 1987. Prior to the establishment of GOSI no much attention was given to safety.

When management found itself in the problem, by legislation, of having to pay for injuries on the job, it decided that it would be financially better to stop the injuries from happening. This decision by the industry all over the world gave birth to the organized industrial safety movement. Management concentrated heavily, if not entirely, on correcting the hazardous physical conditions that exist in work place in the early years of safety movement. This showed a significant decline in the death rate (deaths per million man-hours worked) during the first 20 years of the safety movement. *(Petersen, 1971)*

The interest in safety awareness among construction industry and the whole industry at large has greatly increased in the past decade. This can be attributed to many factors. Recognition of relationship between safety management and return on investment is one of the factors.

2.3 Importance of Safety

Workplace safety is a complex phenomenon and the subject of safety attitudes and safety performance in the construction industry is even more complex. The risk of a fatality in construction is five times more likely than in a manufacturing based industry. *(Sawacha, et al., 1999)* It is not only the workers who suffer from an accident but, directly or indirectly the employer, contractor and the public in general also suffers. The economic effects of an accident can be devastating, apart from human cost of suffering.

Accidents at work occurs either due to lack of knowledge or training, a lack of supervision, or a lack of means to carry out the task safely, or alternatively, due to an error of judgment, carelessness, or apathy. Studies have shown that hazards can be controlled and accidents can be prevented through the implementation of basic safety practices leading to a sound safety program. *(Sawacha, et al., 1999)* Safety cannot be guaranteed by legislation or regulations alone, nor should safety be the sole responsibly of the employer, the employees must be involved. Safety must be a team effort and it requires education and training. *(Koehn, et al., 1995)*

2.4 Safety in Saudi Arabia

In Saudi Arabia 25.5% of the overall establishments are engaged in construction and construction is ranked second after trade & hotels which covers 40%. Construction represents the highest proportion (51.5%) of the registered workers in Saudi Arabia and occupies first position. Above all the major proportion of the overall employment injuries has been recorded by construction, which covers 44.2%. *(GOSI, 1998)*

Accidents in construction industry, results in loss of both property and life. Huge amounts of money are lost apart from the adverse effect on the personnel involved. In Saudi Arabia statistics shows that there is a rise in the number of injuries in construction. *(GOSI, 1998)* One of the major contributors to this increase is the weak safety control and lack of proper measures for safety.

2.5 Safety Economics

To prevent accidents money must be spent. Provisions of safety equipment, planning and design of safe construction procedures need financial supports. One of the objectives in project management is to maximize profit through the safe construction work. Evidently effective safety management is a profit maker for construction companies. Accidents are associated with high direct and indirect costs hence, construction and safety professionals should control these costs. Efforts have been made over the years to establish bases on which total losses can be established from measurable costs. But in every instance, it has been found that the total losses exceed by far the amount reimbursable by the insurance companies.

The types of losses that can result from accidents, injuries or unsafe conditions are shown below. These include the direct, indirect and hidden costs of injury or fatality All of them may not be applicable for every specific instance, and the costs of many are difficult to determine.

1. Payments for settlements of injury or death claims
2. Costs of rescue operations and equipment.
3. Expenditures of emergency equipments
4. Loss of function and operations income
5. Cost for corrective actions to prevent reoccurrences.
6. Degradation of efficiency of operations because of loss of experienced and trained personnel.
7. Increased insurance cost
8. Loss of public confidence, and thereby revenue
9. Loss of prestige
10. Degradation of morale

2.6 Safety Measurement

Indeed real difficulty lies not in determining what objectives are required, but in deciding how to set them. Only fruitful way to make this decision is by determining what shall be measured in each area and what the yardstick of measurement should be. Performance measures ostensibly are concerned with effects. At best they express quality and quantity of results desired from a described activity in this case safety. It helps in motivating the attainment of objectives and to maximize safety performance effectiveness.

Achieving these values usually is not a simple matter. The measurement system must identify the factors, which are most significant to accomplishing the desired results, and it should appraise them reliably. Otherwise the measurement will furnish erroneous information and may be discounted. Such a consequence tends to nullify the purpose and value of performance measures. *(Grimaldi, and Simonds, (1989)*

As far as safety is concerned, its measurement has been confused by the variety of interests, which support its intentions. All of the intentions point to a common target i.e. injury prevention, complicating incompatibilities may occur which diminish, if not destroy the significance of the data obtained. For example, the acquisition of accident data by the insurance companies is directed towards settling claims promptly. Government agencies, are concerned with collecting information that relates to their mandated safety responsibilities. The employer is interested mostly in finding how the accident happened so that he can stop recurrences.

The selection of safety performance measures requires not only choosing a method that will reliably indicate the effectiveness of the safety effort, but also one that will relate clearly to an urgent demand for safety accomplishment. Otherwise, the measure may not furnish the motivation needed to support the safety program sufficiently.

2.7 Quantitative Appraisals of Safety

In past several decades many attempts have been made to determine or rate quantitatively the safety level of plant or any industry. The only means so far employed is through accident statistics, which by their very nature are collected after the event, which is unfortunate. For the accident data to be statistically validated, it must be collected either over long periods of time or from a large number of similar activities.

Accident statistics provide valuable information to insurance companies and regulatory agencies. Regulatory agencies use this data to identify causative factors and to know requirements for additional regulations regarding safety. Insurance companies use this data to determine costs of premiums, which are based on accident and injury frequency and severity rates. The ways to calculated frequency and severity rates are shown below.

Frequency rate: These can be computed in different ways to determine the frequency of accident or injuries, or the severity rate. The methodology is same for all the cases, however the base may be different. If A is the event for which frequency rate is to be calculated, B the numerical base, and C the exposure, then

$$\text{Frequency Rate} = \frac{A \times B}{C}$$

If 1,000,000 men hours are used as the base, an accident frequency rate is computed as

$$Accident\ Frequency\ Rate = \frac{Number\ of\ Accidents\ X\ 1{,}000{,}000}{Man - Hour\ of\ emplyoyee\ \exp osure}$$

Severity rate: The frequency rates were not depicting the true picture, so there was a need for severity rates. For example, one industry may have high injury frequency rates, but the injuries are minor. And some other industry may have few injuries and extremely low injury frequency rates and when injuries do occur they are severe. American National Standard Institute (ANSI) has established a means to of measuring severities through the use of time charges. For this method, fatalities and injuries are assigned time charges to be used in to know severity rates. These time charges are based on average experience. For example, each fatality or permanent total disability is assigned a time charge of 6,000 days. This is based on the life expectancy of the average worker times the number of working days per year.

$$Disabling\ Injury\ Severity\ Rate = \frac{Total\ Days\ Ch\arg ed\ X\ 1{,}000{,}000}{Man - Hour\ of\ emplyoyee\ \exp osure}$$

For the safety engineer the use of accident statistics is less productive. Zero accidents and injury frequency rates are the goals of for the safety engineers. Each and every accident must be of deep concern for the safety engineer and provide a basis for immediate corrective action. Safety engineers do use this data for comparative purposes like:

- How rates for his plant or company with the average in industry.
- To compare the accident frequency, severity rates from period to period.

- To know relatively hazardous operation or activities

2.8 Scope and functions of Safety

The major functions of safety professional/safety are contained within four basic areas. The application of all or some of the functions, will depend upon the nature and scope of the existing accident problems and the type of activity. The major areas are as follows, shown in Figure 2.8-1.

1. Identification and appraisal of accident and loss-producing conditions and practices, and evaluation of the severity of the accident problem;
2. Development of accident prevention and loss-control methods, procedures, and programs;
3. Communication of accident and loss-control information to those directly involved;
4. Measurement and evaluation of the effectiveness of the accident and loss-control system and the modification needed to achieve optimum results.

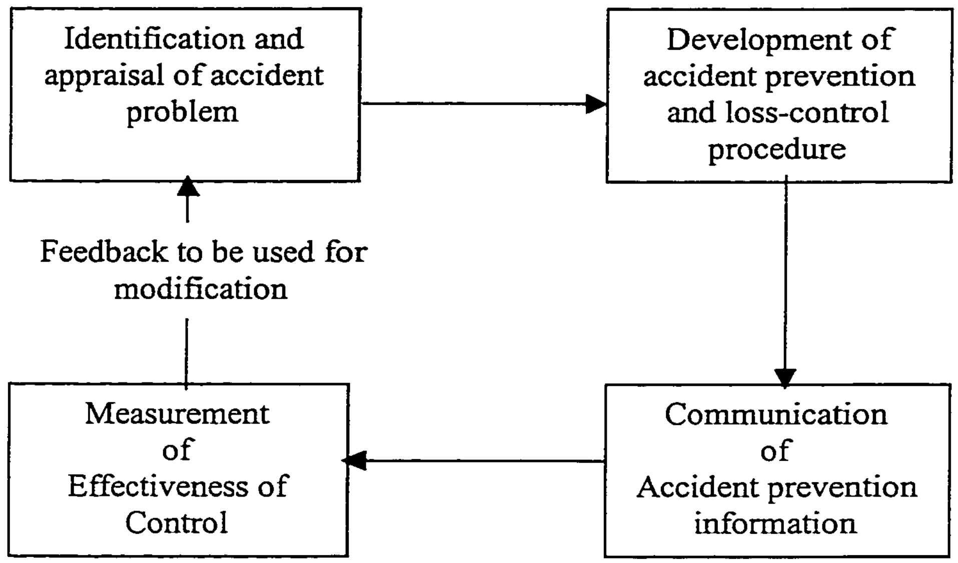

Figure 2.8-1: Functions of Safety Professional/ Safety

2.8.1 Approaches to analyze safety performance.

Approaches to the analysis of safety performance range from the simple to the complex. There some traditional approaches such as accident investigation, inspection, job safety analysis, and so forth and nontraditional approaches such as fault tree analysis, man safety analysis, and so on.

2.9 Factors Affecting Safety Effectiveness.

Once approaches to analysis have been determined the next step is to make determination of what to analyzed, and relevant to results. The areas related to safety performance fall into some specific and distinct categories, some relating to physical conditions, some to the management system that is there to control, and others relating to the behavioral or psychological climate that exists to influence the work force.

A model was developed to show the areas of influence, which can be seen in Figure 2.9-1. This model is based on the belief that safety effectiveness of an organization is determined primarily by current employee behavior. The individual employee behavior is based on first of all on those items in the behavioral influence category. That behavior is very much influenced by the job factors and peer factors. The accumulation of these factors determines current motivation, which, coupled with ability determines behavior.

This current behavior is then filtered by the safety system, including all the items noted in Figure 2.9-1. This behavior is filtered and influenced further by the physical environment in which the employee works. The result is safety behavior, which determines the safety effectiveness. Additionally, the physical environment and the safety system are very much influenced by a number of items, which determine the current corporate emphasis as shown in the Figure 2.9-1.

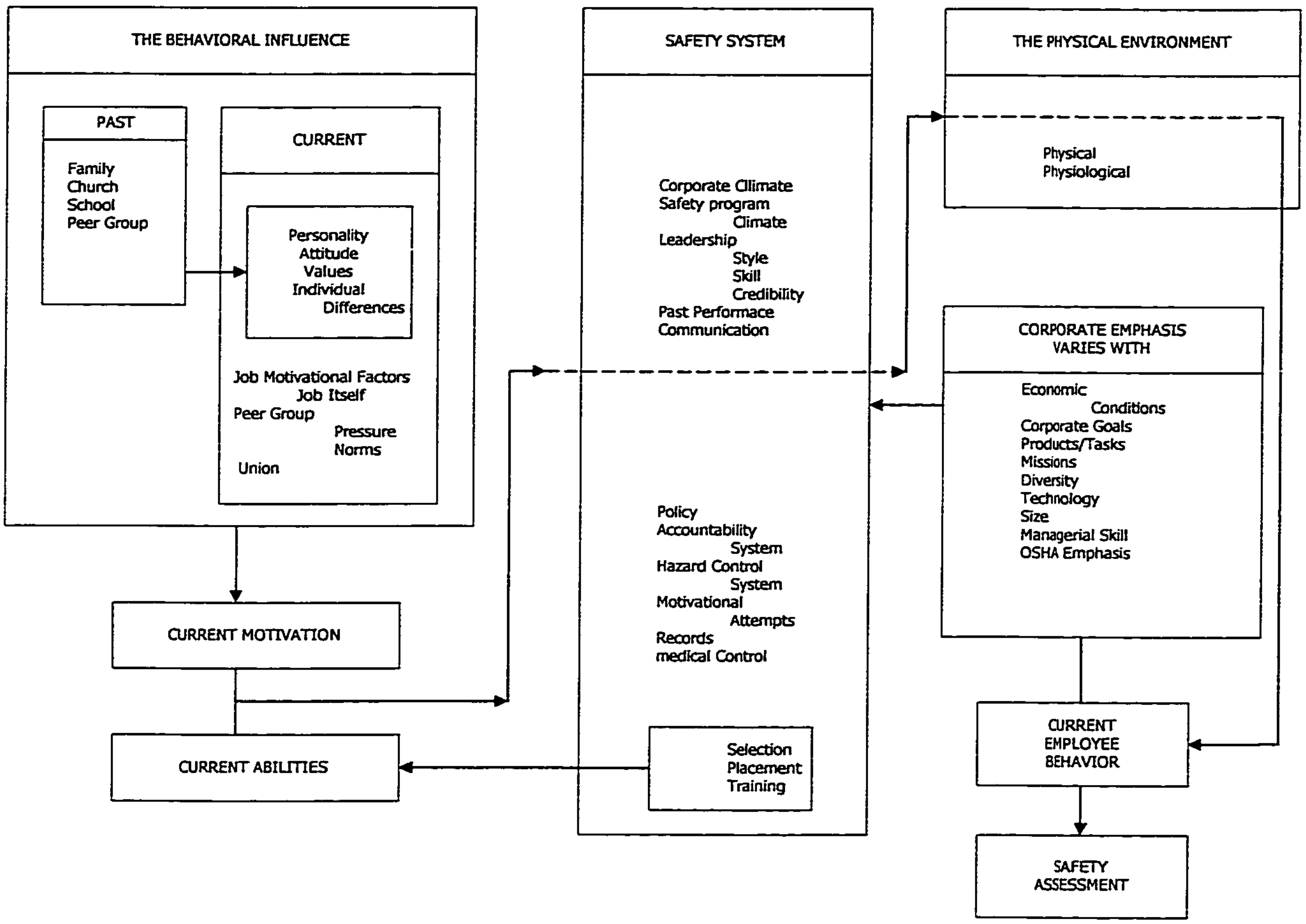

Figure 2.9-1: Factors Effecting Safety Effectiveness

2.9.1 Analyzing Physical Environment.

The physical environment area for analyzing the safety performance has traditionally been given more emphasis then the other two- safety system and behavioral influences. Since the beginning of industrial safety in the early 1900s heavy attention is given to the control of physical conditions.

Some of the systematic approaches to analyze the physical environment are inspections, checklists, job safety analysis and hazard hunts.

2.9.1.1 Inspections

Inspection was and is one of the primary tools of the safety professional. It is the tools used since many decades, before 1931 it was virtually the only tool. However every safety professional should ask one key question who is engaged in inspection: "Why am I inspecting?" The answers to this question dictate how, when, and where to inspect. If the primary intent is to detect hazards that has not been seen before, the inspection is different from the way it is done if the primary interest is in checking on the inspections the department supervisor has made. Some of the answers to the question "Why inspect?" are:

1. To check the results against plan
2. To reawaken interest in safety
3. To teach safety be example
4. To detect and reactivate unfinished business
5. To improve safety standards
6. To spot unsafe conditions
7. To measure the supervisor's performance in safety

2.9.1.2 Checklist

This is simple and effective means of measuring safety performance. The safety walkthrough inspection (or compliance checklist) is the best tool to monitor the engineering aspect of safety program. It is widely used in industry since 1950s. The checklist consists of items whose presence or absence could jeopardize safe operation. It may vary in intensity and scope, but in essence the procedure and objective are the same wherever it is employed. Which is almost universal. The appraisal may well be defined by a list of specifies for safety assessment. The checklist helps identify the specific nature and location of hazards or cases of noncompliance, it can be used to track abatement efforts.

The program elements included are formation of safety committees, whether they meet, site layout & housekeeping, protective equipment, fire protection etc. Safety checklists was used in this research, to assess the safety performance of the industrial construction projects. Checklist used in this study is a modification of standardized checklist from literature and Saudi Aramco checklist. (Jannadi, & Assaf 1998) It includes those items, which are perceived to be important from the safety point of view on the industrial construction project it is shown in appendix. To serve as a good tool for assessment, the checklist must be quantified. One common approach is to assign a single point value for each hazard or noncompliance observed. The checklist score can simply be calculated as the total of points.

2.9.1.3 Job Safety Analysis

The procedure, which is used to uncover hazards that may have been overlooked in the design of machinery, equipment, design of facilities, work processes, and work practices, is term as job safety analysis (JSA). The main purpose of job safety analysis is to identify hazards that may have developed after the facility is put in operation and work started. As a job is analyzed, it will be found that some job steps have no hazards associated with them. On the other hand, one step may reveal several hazards or potential accident-triggering items. Following are fours steps in the job safety analysis.

1. Select the job

2. Break the job down into its successive steps

3. Identify hazards and code violations

4. Eliminate or control hazards

The benefits from the use of job safety analysis are safer working procedures and conditions, more effective accident investigation and of course fewer accidents.

2.9.1.4 Hazard Hunts

This is another way to identify hazard by involving employees. The employees will not know the details of standards. But they will have some idea of the hazards they see daily or face on the job. The major problem occurs when the hazards are potentially long term. One good example is exposure to harmful solvents in small, but still dangerous concentrations. When the hazards are purely mechanical employees' feedback is very important.

The procedure followed in hazard hunt can be summarized in following steps.

1. Each supervisor will be provided with pads of hazard hunt forms

2. Supervisors then held a five-minute session with his group, asks their help, and gives each member a form

3. Employees will merely note down anything that they feel was a hazard and return the form to the supervisor

4. The supervisor will review the forms, correct whatever hazard he could, and submit a list of others to staff safety for discussion and scheduling.

2.9.2 The Safety System

William Johnson defines the safety system as the management system. At its simplest level it has six elements. The major elements in the safety system are:

1. A management Decision Process

   It utilizes objectives, requirements, resources, and constrains to establish goals and which develops policies, organization, plans, and implementation of a repertory of management methods, which require the evaluation of, planned changes.

2. Work Flow Process

   It utilizes supervision, things, people, and procedures derived from upstream processes, like design, construction, training and so on.

3. Performance

   It is basically output, but usually with risk. Deviations like accidents, errors, malfunctions, and so on, degrade the performance and produce waste and are the result of system failure.

There are four key factors affecting safety system and other functions in an organization, which are technological, human, organizational, and social inputs. The first three factors in the safety system are visible, but the fourth one, social factor has been treated as an aspect of the human factor, to be affected by and also affecting the participative aspects of the system.

The system approach to safety is a method of thinking which forces one to understand and describe a process; such descriptions help guard against oversights and weaknesses and also set the stage for monitoring the process. The system approach provides a logical way to determine where a safety problem is in the hazard reduction process or where a problem is slipped through the prior hazard reduction process. The elements of safety system are:

1. Management implementation of sound safety policy
2. A defined analysis process to minimize errors and oversights
3. Work situations which provide the environment and direction to enable people to perform capably and safely
4. An information system which provides
    a. Monitoring to promptly detect risk
    b. Knowledge of hazards and corrective measures
    c. Prompt adequate feedback on safety performance

2.9.3 Analyzing the Safety System

There are many ways to analyze the safety system, like surveys, audits, profiling, safety system etc. Some of the methods are described in the following paragraphs.

2.9.3.1 Surveys

The way the worker perceives the company safety program strongly influences his behavior and his ability to learn from and to respond to safety suggestions and materials. The best means of assessing safety system and knowing the perception of workers is through the use of surveys. Based on surveys industries can me classified and it gives clear picture of safety program. This helps in improving safety attitude of employee and the employer.

Surveys have long been used in non-safety applications; the pioneer of this technique was Dr. Rensis Likert. He developed a survey that measured employee perception of 10 areas:

1. Confidence and trust
2. Interest in the subordinate's future
3. Understanding of, and the desire to help overcome problems
4. Training subordinate to improve his performance
5. Teaching the subordinate how to solve problem rather than giving answers
6. Giving support by making available required physical resources
7. Communicating information that the subordinate must know to perform the job, as well as the information needed to identify more with the operation

8. Seeking out and attempting to use ideas and opinions

9. Approachability

10. Crediting and recognizing the subordinate's accomplishments

Surveys should include the corporate climate and safety program climate. These aspects of climate have major influence on the behavior of both management and employees. There is possibility of difference of perception of safety between employee and management, it should be considered in surveys. Researchers have classified companies into four types: *(Peterson, 1998)*

Over-zealous Company: A great deal of emphasis is on safety. Workers are required to wear safety equipment and machines have to be guarded. Over-zealous companies require procedures to be followed. These companies emphasize regular safety meetings, safety films, safety manuals and safety procedures.

Rewarding Company: Companies, which offers awards for safety performance to its workers, are classified as rewarding. These companies give symbolic awards to its workers who are not involved in any violations. The employees in these companies are encouraged to be safe and they feel the importance of the safety program. Awards make them feel that how their employer care about safety.

Lively Company: These companies create a safety program that stimulates competition among various departments within the company. Departments have to record the number of hours passed without accident and the winning department will receive a prize. In these companies, safety becomes a goal that needs to be achieved rather than just avoiding accidents.

Negligent Company: Companies that does not have an established safety program and it reacts to safety matters after some accidents take place are classified as negligent companies. The employees in these companies feel that the management doesn't care about safety and safety equipment and materials are just meant to protect the management.

2.9.3.2 Audits

It is a management tool used to measure the effectiveness of an organization's safety program in meeting its goal and objectives. Audits are an in-depth analysis of the facilities, the management and employee attitudes towards safety, the management effectiveness in maintaining safety and the quality of the safety planning. (Al-Utaibi, 1996)

Selected people who are not involved in the operation should perform audits and it should accomplish the following:

1. Determine if the organization's safety program is meeting its objectives or goals.
2. Establish employee participation and personal accountability in safety matters.
3. Evaluate the effectiveness of the safety program regardless of the strengths and the weakness of the other areas within the organization.
4. Identify and correct any operation, procedure or equipment that is in violation of laws, regulations and standards.

5. Identify the strengths and weakness of the current safety system.

6. Constitute a basis in formulating an improvement plan that can easily be communicated to all levels of management within the organization.

The way to perform audits is very simple and the format consists of three parts: Activity Standards, Ranking form and summary sheet. The forms required for auditing at every stage are shown in appendix.

Activity Standards: This is a standard form used to rate industries based key activities in different areas. Each activity is clearly defined and has a four rating, via Poor, Fair, Good and Excellent. The requirement for each rating is defined and is shown in the appendix.

Rating Form: In this form each specific area is given rating. Each rating i.e. Poor, Fair, etc will be assigned a value as illustrated in appendix. Each activity will be assigned values based on its rating. Rating in each activity will be summed up to get a gross total in each area. Final rating of the specific area will be calculated by adding all the rating in the specific area and then multiplying by weights of the areas. (Al-Utaibi, 1996)

Summary Sheet: This sheet is used to aggregate the total score for an organization and give rating. The final score for each area calculated in the rating form will be registered in the sheet shown in the appendix. Then the scores for all areas will be added to give the final rating of the organization. The numerical values to be entered are the weighted ratings calculated on the rating sheets. The total becomes the overall score for the organization.

2.9.3.3 Profiling

It is a means of evaluating the organization is safety effort. The purpose is to compare the experience of a plant or industry with that of another which is comparable. It is similar to auditing, but it is more elaborate and often accompanied by charts.

Profiling was first presented by a Canadian safety professional, Jack Fletcher, in a book titled "The Industrial Environment". In profiling, organizations are rated and graded and industries in the area of injury prevention, damage control, total loss control, guarding, inspection, design, committees and rules, training, investigation, record and analysis, and personal protective equipment. Organization will be rated as unsatisfactory to excellent based on the scores from 0 to 5.

2.9.4 Analyzing the Behavioral System

In the past decades very little attention is paid to the behavioral system and its analysis. The performance of the employees depends upon two things his ability and his motivation. Performance of employee means his carrying out of assigned tasks in the manner desired by the industry. The factors that determine his ability to do the task are selection and training.

Motivation is determined by factors, which are somewhat more important and more complex. Motivation means, simply, "Does he want to work (or need to) perform?" The behavioral influence may be considered in two components, the past influence and the current ones, as shown in Figure 2.9-1.

The behavioral system can be analyzed with a simple checklist of things. The checklist can contain points like whether or not management has provided supervisors with any methods to access the behavioral influences on the individuals working for them. Some of the points to be included in this checklist are:

1. Is there a systematic way provided for supervisors to assess their people?
    a. Their Beliefs
    b. Their values
    c. Their personality/accident risk
2. Is there a systematic way provided for supervisors to assess their people current needs?
    a. For independence?
    b. For equality?
    c. For an enriched job?
3. Is there a systematic way provided for supervisors to assess their peoples' level of?
    a. Motivation?
    b. Satisfaction
4. Is there a systematic way provided for supervisors to assess their own leadership style?
5. Is there a systematic way provided for supervisors to assess their peoples' level of?
    a. Strength
    b. Direction

2.9.5 Methods of Safety Performance Measurement

Many methods exist and have been proposed for gauging the merits of safety program and measuring safety performance. This can be classified as systemic and organic. To achieve some clarity in the consideration of safety performance measure, it is useful to classify the objectives to be served. The organic or fundamental, attempts to evaluate how well the

elements and their implementation. The systemic or general is concern with the effects of the program, i.e., the achievements of the aims the program is designed to serve, for example reduction of fatalities, the saving of money, etc.

Systemic Measures: Most common methods of quantifying safety performance are ratios of unwanted events (generally a specific classification of injury) and the exposure, usually stated as a function of time. Frequency rate, Severity rate, incidence rate are few examples of systemic measures. These all have their own advantages and disadvantages. These measures are used with many alterations.

Since safety effectiveness measurement scale with limits that are injuries (or accidents) related do not seem to express adequately the quality of the performance effort, measuring means, which do not employ injury data have been proposed. These tools help track the past effectiveness of safety program. They do not however, identify areas of concern or reveal specific problems.

Organic Measures: These are concerned with the fundamental aspects of safety performance. It is probably preferred to have a measure that can evaluate the total effect of the safety system; it is useful to evaluate the parts of the safety program. In this type of measure, answers to few questions are sought, for example: Is the program effective in modifying unsafe behavior? Have injury-producing physical conditions been corrected?

productive in appraising plant safety than is knowledge of hazards, control, checklists and similar information. The most common of these appraisal techniques are checklist, audits, profiles and surveys.

2.10 Previous Safety Research

A survey of the U.S. construction industry shows that the majority of contractors spend less than $25,000 annually on safety education. This is a relatively small expenditure. Nevertheless, according to a Business Round Table report, the cost of an effective construction safety and health program in the United States is approximately 2.5% of direct labor costs. It has also been found that management support is vital for any successful safety program. In this regard, studies have shown that hazards on sites can be controlled, and accidents can be prevented through the implementation of basic safety practices leading to a sound construction-safety program. The implementation, operation, and monitoring responsibility of the program should be clearly defined at the beginning of the construction activities *(Hinze, 1997)*

The Role of Human Factors and Safety Culture in Safety Management by R.T. Booth and T.R. Lee was one paper in which, the authors described the recent changes in health and safety regulations in U.K., the most substantial one was the Regulations on Management of Health and Safety enacted in 1993. In parallel with legal development, it is believed that safety culture is the most important key factor of safety performance in an organisation. The safety culture is a description of the attitudes of personnel about the company they work for, and their perceptions of the magnitude of the risks to which they are exposed. The authors recommended some characteristics of organisations with a positive safety culture. In developing a safety culture, the dominant management themes to emerge include: the commitment of chief executive, the executive safety role of line management, involvement of all employees, openness of communication and demonstration of concern for all those affected by the business. *(Booth & Lee, 1993)*

In a book titled "The Costs of Accidents at Work by Health & Safety Executive (HSE) UK, 1993" case studies were complied of different industry in UK to quantify the losses at accidents. According to Health & Safety Executive, successful health and safety management is based on the principles of loss control and quality management. In the case studies presented in this book adapted the ratio of insured/un-insured costs by which most of the organisations could be able to estimate their potential loss more realistically. The accident iceberg ratio diagram for a construction industry reviewed the hidden cost of accident was as high as 1:10. *(HSE)*

Construction Industry Institute (CII) conducted a study titled "Zero Injury Techniques" (1993), in which information to help owners and contractors to achieve zero accidents on their construction sites. This goal was to identify the most successful techniques being used to achieve the zero accident objective.

As this research was being refined, a total of 170 key safety techniques were identified. The research team conducted 482 interviews on 25 projects that were being constructed by approximately 15 different firms. The individuals interviewed included primarily owner managers, construction managers, construction supervisors, and construction workers.

Each person interviewed was asked questions regarding each of the 170 key safety techniques. While several questions were asked, perhaps the singular most important was "What are the three most effective safety techniques used on this project?" The responses regarding the perceived most effective techniques were compared to the safety performance records for the respective projects. From this evolved the five High-Impact Zero Accident Techniques. These can be summarized as follows:

(1) pre-project/pre-task planning for safety,

(2) safety orientation and training,

(3) written safety incentive programs,

(4) alcohol and substance abuse programs, and

(5) accident/incident investigations.

In a research study conducted by the Office of Oversight Analysis, U.S Department of Energy (DOE) (1998), five major issues or themes based on the Office of Oversight qualitative information and Occurrence Reporting and Processing System (ORPS) quantitative data were discovered. They are as follows:

1. Poor management control remains at the root of construction safety shortfalls

2. Historically, construction safety has not been effectively integrated into site operations. Consequently, the proven attributes of an operational safety program have not been applied

3. Construction contracts do not necessarily provide adequate requirements, standards, and enforcement provisions to ensure adequate planning, oversight, and safe performance

4. Adequate methods are not in place to define and assess the qualifications of workers associated with construction work in DOE. As a result, it is difficult to ensure that the only qualified personnel are hired

5. Management of the skill mix during the transition from an operations and production workforce to one of D&D involving extensive construction activities has not been effective at some sites. These sites lack a skilled staff with extensive design and construction expertise to plan and supervise required tasks effectively

Statistics indicate that construction employees account for approximately 6 percent of the total labor force, but they incur 12 percent of all occupational injuries and illnesses and 19 percent of all work related fatalities. Construction safety needs continual reforms. Through the implementation of progressive safety programs, checklists, and innovative management techniques, the number of accidents and fatalities could be reduced. *(Nancy & Janet, 1997)*

Accidents in the civil engineering/construction industry tend to be costly in both human and financial terms. These expenses may be concentrated in the areas of health care, litigation, management time, worker compensation, and Occupational Health and Safety Administration (OSHA) sanctions. Other expenses include transportation costs; loss of productivity of workers, the cost of fixing or replacing damaged equipment or materials, and the cost of hiring new workers *(Hinze, 1992).*

Detailed analysis of data recorded by OSHA can provide meaningful information about the sources of citations and the causes of fatalities. For example, it is evident from the Integrated Management Information System (IMIS) data that in recent years that hazards communication has emerged as the OSHA standard for which employers have received large number of citations *(Hinze & Russell, 1995).*

As part of its mission, OSHA collects data associated with injuries and inspections. While a wealth of this OSHA raw data exists, it is not rigorously analyzed on a regular basis. Careful and regular analysis of the data could provide very meaningful information to employers in those areas in which greater attention should be devoted *(Hinze & Russell, 1995).*

Since 1971, OSHA has had as one of its directives the role collecting data on the causes of construction fatalities. This information is collected by OSHA compliance officers when they visit construction sites on which fatalities or serious injury have occurred and is recorded in OSHA's IMIS *(Hinze et al., 1998).*

In the past decades many parties in the construction industry have become very interested in finding ways of curbing construction-related injuries and fatalities. Much of this interest is rooted in the escalating costs of injuries, largely attributed to the rising costs of medical treatment and convalescent care. *(Hinze et al., 1998).*

The U.S. Department of Labor, Bureau of Labor Statistics, reports an average of one death and 167 injuries per $100,000,000 of annual construction spending. Based on Business Round Table Report A-3, the cost of these accidents totalled $8.9 billion or 6.5% of the $137 billion spent annually by users of industrial, utility, and commercial construction *(Koehn, et al., 1995).*

The death rate today for construction workers in the United States appears to be substantially higher than in the Netherlands, Sweden, and Ontario, Canada. Since 1970, construction fatalities have been reduced by 75% in Sweden; since 1965 construction fatalities have been reduced by 83% in Ontario, Canada *(Koehn, et al., 1995)*.

It is clear that no one audit or assessment tool can possibly serve every organization's needs; it is unlikely that a single instrument can even meet all the needs of one company, states the National Safety Council. What then, is required? The answer: Several instruments used concurrently. *(Taggart and Carter, 1999)*

The construction industry on average has a higher rate of occupational injury than most other industries. However, steps can be taken to reduce worker risk through the effective management of controllable factors. These controllable factors can be managed through aggressive safety program with an emphasis on hazard awareness, safer work practices, and employee involvement *(Harper & Koehn, 1997).*

The responsibility for safety on any construction project should be shared between all the parties involved in the project, namely, the owner, the designer or architect and the contractor. The owner, as part of his safety responsibility, must ensure that the designer designs a safe project. He must also ensure that the contractor has a safety program. (Jannadi & Assaf, 1998)

It was found in a study conducted by, Jannadi and Assaf (1998) that safety levels varied between the large and small projects. Small projects averaged low safety assessment scores in fire prevention, health and welfare and safety administration, while safety assessment scores in large projects were consistently high in all different divisions. This indicates the need for implementing a safety code in Saudi Arabia to monitor and enforce safety requirements at work. (Jannadi & Assaf, 1998)

In a research carried out by Jannadi (1995), impact of human relations on the safety of construction workers, it was found that an effective use of human relations would improve safety programs and make safe behavior a habit for workers. It was also found that safety performance of each worker was very much related to his attitude towards his fellow employees, foreman, and employer. One more conclusion from the study was that management's attitude towards worker's welfare can also play a major role in developing safe behavior among the workers and thus a safe performance in the workplace.

2.11 Jubail Industrial City

The industrial area at Jubail is home to all sorts of industrial enterprises — from world-class refineries and petrochemical complexes to smaller plants producing copper pipe, plastic bags, and even dairy products. To date, nearly 100 square kilometers of land has been reserved for industrial use at Jubail. This area is divided into three major sections — for primary, secondary, and support and light manufacturing industries. The primary industries are mainly export-oriented, large-scale complexes, many built as joint ventures between the Saudi government and leading international corporations. The other industries add further value to primary industry products or provide other essential goods, manufacturing, and services.

Together, Jubail's industries provide employment for tens of thousands of people in the greater Jubail area while making a major contribution to the economic diversification of the Kingdom.

2.11.1 Primary Industries

The economic heart of Jubail Industrial City is its Primary Industries Park. This area is currently host to 17 manufacturing facilities, 16 in operation and one about to come on stream. Together, they represent an investment of over $19 billion. Employing the most up-to-date technology, these industries turn out various high-quality products at a rate of approximately 40 million tons per year. With the exception of the steel mill, all of these primary industries use the Kingdom's hydrocarbon resources for their feedstock. Most of their output is exported, although a steadily increasing amount is becoming, in turn, feedstock for downstream industries.

Two organizations are chiefly responsible for primary industry development at Jubail, as at Yanbu. Saudi Aramco is responsible for the operation of oil refining and bulk storage facilities, as well as plants that produce sulfur and industrial greases. Saudi Basic Industries Corporation builds and operates plants that produce petrochemicals, plastic resins, fertilizers, metals, and industrial gases. Both Saudi Aramco and SABIC operate either directly or through joint ventures with private firms.

With 13 primary industries in operation, SABIC is far and away the largest industrial investor and employer at Jubail. Its many and diverse enterprises have contributed enormously to the industrial diversification of the Kingdom and made Saudi Arabia a leading manufacturer of petrochemicals.

2.11.2 Secondary Industries

The pace of secondary industrialization at Jubail has accelerated in recent years. Since 1987, when the first of these major downstream industries started operations in the Secondary Industries Park, 18 more have begun manufacturing various intermediate and end products. In many cases, Jubail's own primary industries provide the essential steel, plastic, petrochemicals, and other feedstock required by the secondary manufacturers.

The combined investment of secondary industries currently operating at Jubail is approximately $700 million. Similar projects in active planning or design account for another $1.9 billion of investment.

2.11.3 Light Manufacturing and Support Industries

Light manufacturing and support industries consist of smaller industrial and heavy-commercial enterprises. Some of these are manufacturing facilities that represent the last step in the value-adding process that begins with a primary industry product. Others offer services to industrial clients and the community at large.

Jubail's Light Industries Park is home to more than 125 light manufacturing and support operations, representing a combined investment of over $500 million; another 20 enterprises are projected to be doing business by the turn of the century. Many of these manufacturers are producing goods that are being made in Saudi Arabia for the first time.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents the steps that were followed for achieving the objectives set for the study. Assessment of the safety performance in the industrial construction project was the main objective of this study. The following paragraphs describe the phases of this research. The main sources of collecting data for this research were through comprehensive literature review, questionnaires, and walkthrough inspection using checklists. The phases of this research are shown in Figure 3.7-1. The objectives were achieved in the following phases:

3.2 Phase 1: Literature review

Extensive literature review was carried out to acquire the in-depth understanding of the issues related to safety performance. This provides a sound background for the exploration of various problems that are associated with the topic in Kingdom of Saudi Arabia. Many articles from journals, books and Internet were referred in literature review.

3.3 Phase 2: Development of questionnaire and checklist

The next step towards the objective was to develop questionnaire and checklist to be used in the study. Information gathered through the literature review was used at this stage. The questionnaire contains various issues related to the management and employees perception of safety in an industrial construction project. These questions were addressed to cover areas, which have greater influence on the industrial construction safety. Two separate questionnaires were developed and used in this study, which are shown in the appendix. The questionnaires are shown in appendix.

In order to address the physical aspect of industrial construction projects a comprehensive checklist was developed. This checklist covers important aspects of industrial construction, which has major impact on safety. The checklist is shown in the appendix, which is a modification of Saudi Aramco inspection checklist and list of concerned areas from civil construction safety manual. The checklist will cover areas related to following safety aspects:

Safety administration	Barricades and fencing
Housekeeping	Excavation and shoring
Fire prevention	Scaffolding
Electrical/utility	Wielding and cutting
Hand and power tools	Personal protective equipment
Heavy equipment	Electrical/utility
	Material Storage

3.4 Phase 3: Data collection

The next step was to identify certain industrial construction projects in Eastern Province of Saudi Arabia for the safety assessment. Data required for the study was collected in two parts. Firstly, data concerning the physical aspects of safety was collecting by walk through inspection utilizing checklist.

Secondly, data regarding the safety perception of the employees and employer was gathered by administrating questionnaire. The questionnaire address administrative and managerial areas like safety meetings, accountability, job schedule, assigned safety staff, importance of safety to the employer and employee. Two separate questionnaire were utilized one for the project manager or the representative of management, to know the commitment and perception of management, another questionnaire was administered to the safety engineer/professionals to know their attitude and management support regarding safety.

3.5 Phase 4: Analysis of data

Data collected by means of questionnaire and checklist was separated and analyzed. A detailed analysis of the data was conducted using appropriate statistical analysis tool. The analysis will highlight trends in safety performance of the industrial construction projects in Saudi Arabia. The data will also be analyzed to find the correlation between different aspects of safety.

3.6 Phase 5: Provide conclusion and recommendations

The results were summarized to provide conclusions. Based on the statistical analysis of the responses to the questionnaire and data collected by means of checklist inspection, strategies were recommended to mitigate the safety-related problems and to improve the safety performance.

3.7 Questionnaire Design

The two questionnaires were designed to study the safety perception and attitudes of the Project Managers/Engineers and Safety Professionals. It was also desired to understand how they think their responsibility in an accident. The questionnaire for Project Manager was divided into six categories, containing twenty-eight (28) questions in all. In first area, seven questions were asked to know general information about the industry and respondent. In the next four sections, the respondents could tick one of the five options depending upon their understanding. The second section consists of four (4) questions regarding administrative aspects of safety. Third, fourth and fifth sections asked questions concerning the Management support, Planning meetings and Management safety policy respectively. The respondents were asked to evaluate based on a five-point scale ranging from "Always" (Yes) to "Never" (No). The sixth and last section consists of five (5) questions regarding the respondents' general perception about safety.

Safety professional's questionnaire, consists of thirty-one (31) questions spread over eight (8) areas. The eight sections are general information, Management support, Safety meetings, Inspection and investigation, Training, Record keeping, Medical facilities and welfare and general perception. In first seven sections the respondents were asked to tick any one of the best answer from five options. In the eighth section, General perception, the respondents were requested to show the degree of agreement of the given statements. The last section was regarding the Injury/accident data. To facilitate the fax communication, both the questionnaires were particularly formatted into two pages, sample questionnaires are shown in *Appendices*.

3.7.1 Procedure and difficulties encountered

The targeted area for this study was Jubail Industrial city as the study deals with the safety management of industrial projects. Details like contact addresses, fax, phone numbers and activities of one hundred and fifty seven (157) industries were obtained from Chamber of Commerce, Eastern Province and Royal Commission for Jubail.

To make it an organized effort, request letter for participation, along with a form for appointment was send to all industries, which can be seen in the appendix. To ensure questionnaires reaching the concerned personnel and gets due attention, it was followed up by phone calls. Request letter was send again to those companies, which did not respond after considerable time gap. This time, it was send to the concerned department and personnel. More than hundred-fifty (150) letters were sent. Once the appointment is received, the next step was to send the thanking letter along with the questionnaires, so that the concerned personnel have a look. The outcome was fairly satisfactory. About 40% responded - twenty-six (26) companies were visited.

With respect to the apathetic attitude on questionnaires especially in sensitive area of safety, getting more than 40% of response was encouraging. The research team is grateful and takes this chance to express sincere thanks to all the companies and professionals who voiced their attitudes and valuable opinions on construction safety. However, it was really timely to collect physical data and administer questionnaire with the professionals. Not surprisingly, most of the project engineers and safety professionals played important role in construction projects; they would be tied up with heavy job responsibilities. In many cases, several visits have to be made to the companies in order to complete checklist and questionnaires.

3.7.2 Sample size

The survey was started with the selection of target respondents, from Chamber of Commerce and Industry, Eastern Province and Royal Commission for Jubail. The sources provided details about 74 industries in Jubail. This group of industries contains small consultants and small business, which were sorted out and the net population was fifty-eight (58).

The minimum number (sample) of industries that would represent the total population can be calculated based on the following formula (Kendall, 1970).

$$n = \frac{n'}{(1 + n'/N)} \qquad \frac{S^2}{V^2}$$

where;

n = sample size

N = size of finite population

S^2 = The maximum variance estimate. It is estimated by $S^2 = P(1-P)$, where P is the proportion of the population, the maximum value is chosen as P = 0.5

V = Standard deviation of the sampling distribution. 0.05 is a reasonable estimate of V.

n' = The value of industry distribution.

By applying the above formula on the industries population of 157, the sample size will be;

$$n' = \frac{(0.5)^2}{(0.05)^2} = 100 \text{ and } n = \frac{100}{1+\frac{100}{74}} = 42.53$$

The minimum required response rate was (42.53/74) x 100 = 57.47%. However, the actual response rate was (28/42.53) x 100 = 66.67%, which is a reasonable sample size exceeding the minimum requirement.

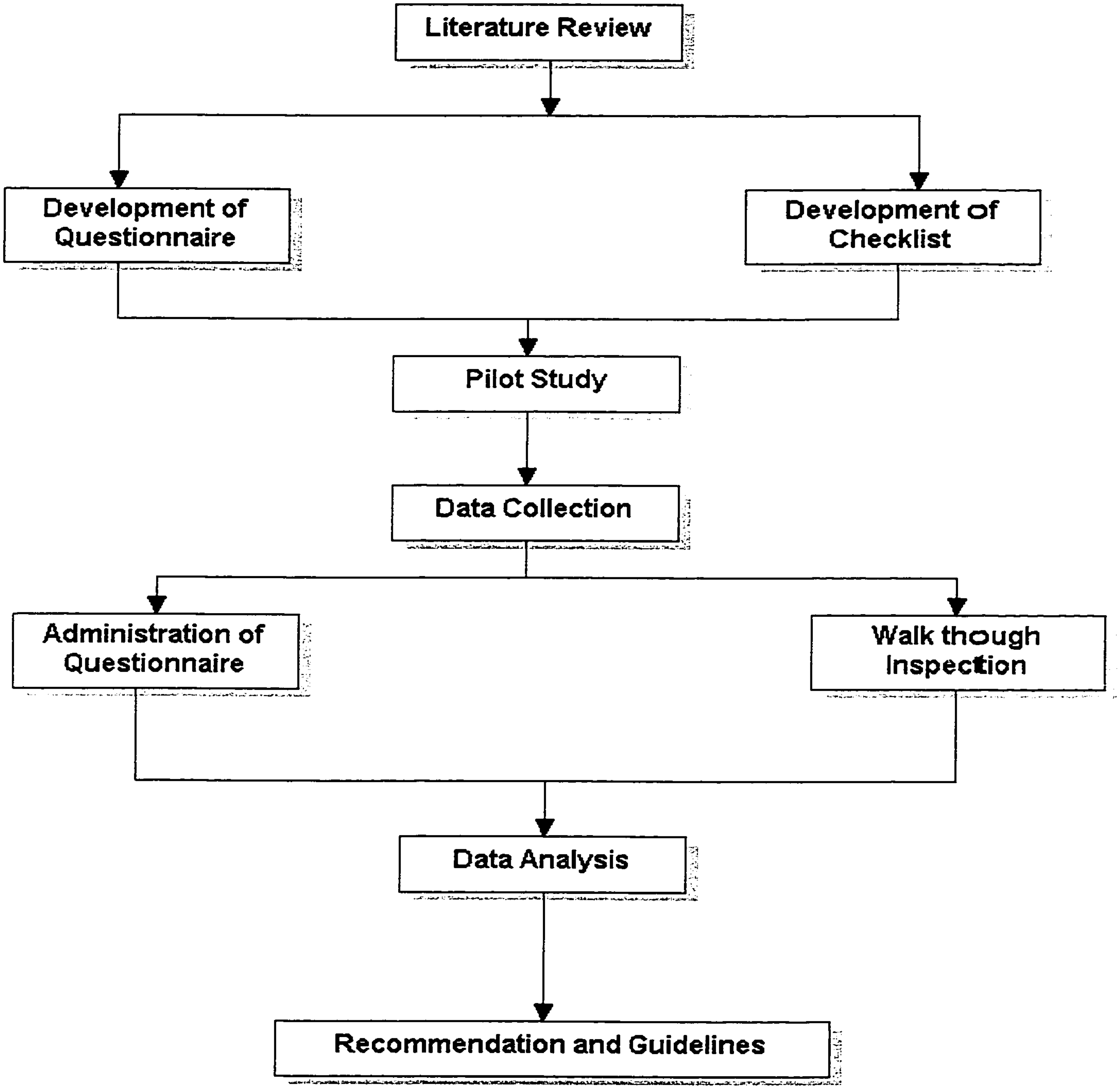

Figure 3.7-1: Research Methodology

CHAPTER 4

SAFETY PERCEPTION SURVEY

4.1 Introduction

This section analyzes the data regarding the general perception of the respondents based on the filled questionnaires received from twenty-eight industries. Project mangers were requested to give information about their perception towards safety. Specific questions were asked to know the perception about factors like: reasons for accidents, responsibility for accidents, suggested expenses for safety and effect of TQM implementation.

Safety professionals were requested to give input about their perception and questions related to factors like, allocation of cost, reasons for accidents, adequacy of safety regulation, safety knowledge etc were asked.

4.2 Project Manager's Perception

The survey was aimed to measure the commitment and perception of the management. The project managers are the management representative and their perception somewhat reflect that of the management. Thus this phase of survey was targeted towards project managers in order to measure their commitment towards safety program.

4.2.1 Years of Experience

The years of experience vary from less than 2 years to more than 15 years. Most of the project managers are experienced and 92.8% of the respondents have at least 2 years of experience. Only about 7.1% of the respondents have less than 2 years of experience. About 39.3% of the project managers have 2-5 years of experience and it is the highest range of experience.

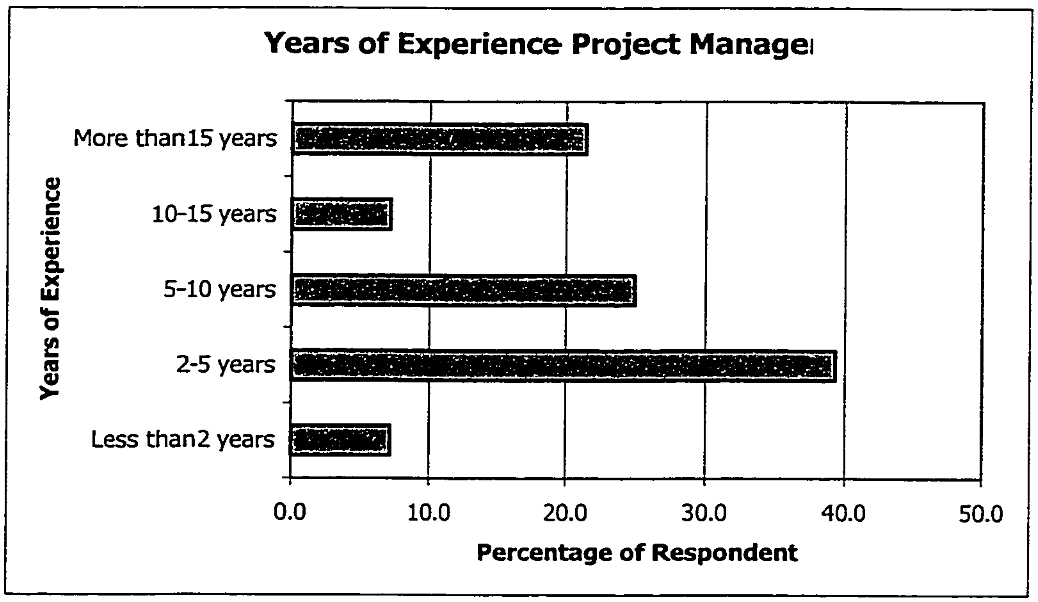

Figure 4.2-1: Project Manager's Years of Experience

4.2.2 Reasons for Accidents on Site

Project managers were requested to give information about their perception towards why accidents happen on site. They were specifically asked to comment on 1) the management's shortcoming and 2) the worker's lacking, which may be the major reasons of accidents on site.

The major reasons that may cause an accident are lack of proper training and organizational culture. Nearly 67% of the respondents have this view. About 38.9% of the project managers perceive that lack of training is the major reason for accidents on site. About 27.8% of the project managers feel that organizational culture is the major reason. The remaining 33.3% of the project managers perceive safety policy; commitment and safety staff are the major reason for accidents.

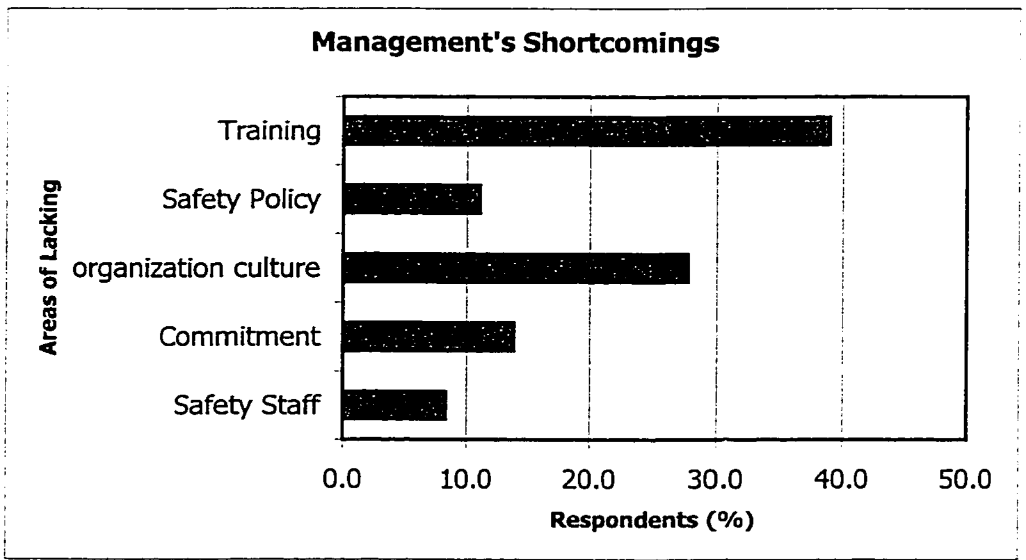

Figure 4.2-2: Management's Shortcomings

Project managers were asked about the areas, which, they feel need improvement, concerning the worker commitment and environment. The major reason for accidents on site is that the worker's lack training, nearly 33.3% of the project managers have this perception. About 25.6% of the project managers feel that the workers lack motivation. And 23.1% said that the major reason for accidents is that workers lack working instruction. About 17.9% pointed out that the workers lack organizational culture and equipment.

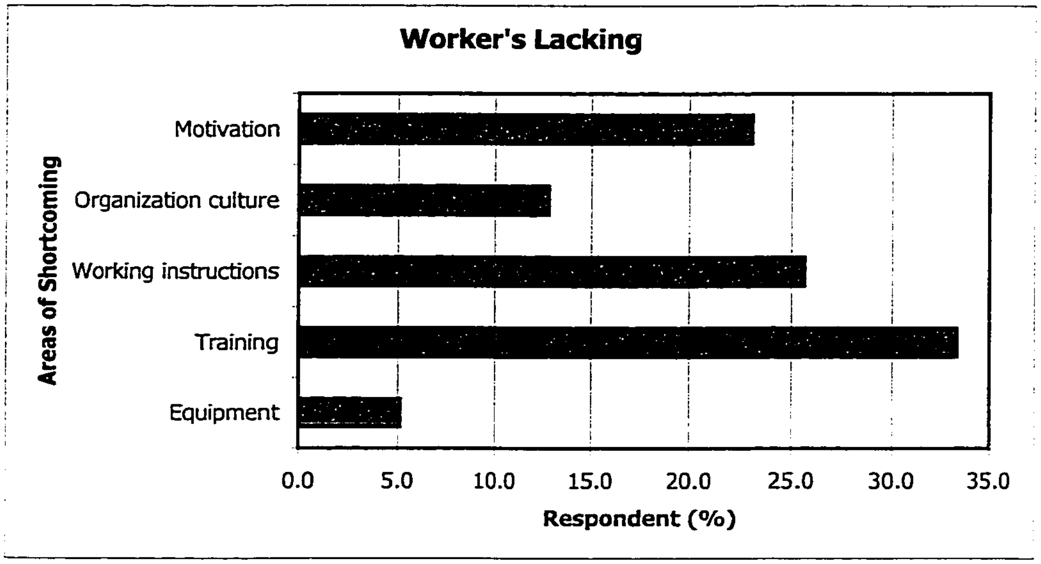

Figure 4.2-3: Worker's Lacking

4.2.3 Responsibility for Accidents

The project managers were requested to answer the following question, to know their view on the responsibility for accidents. They were asked "In your opinion, who should be responsible for accidents on industrial construction sites?".

Majority of the respondents feel that accidents on site are the responsibility for all the parties involved. The party that has the main responsibility for accidents on site, according to the project manager's perception is management. Nearly 28.6 percent of the managers feel that management is responsible for accidents on site. The next two parties, which are responsible, are workers (23.8%) and safety officer (20.6%). Only 9.5% of the respondents feel that, the government has responsibility for accidents on site. About 17.5% of the respondents have view that the engineer is responsible for accidents on site.

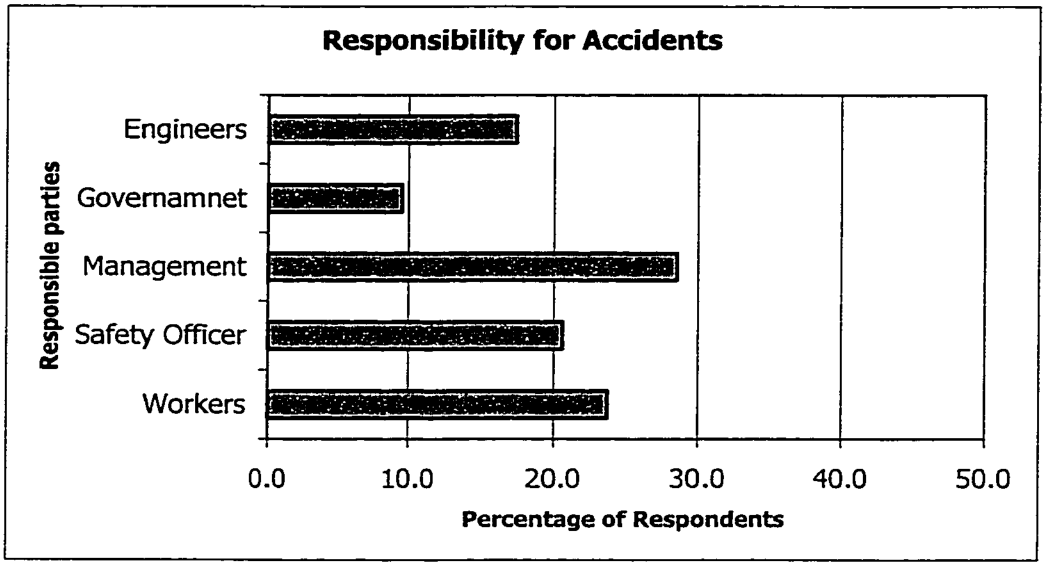

Figure 4.2-4: Responsibility for Accidents

4.2.4 Suggested Expenses

Project managers were requested to give their opinion on the amount, which is required for safety on projects. Majority of the respondents have the opinion that, the expenses depend on the nature, size and complexity of the project. About 57.1% of the project managers feel that expenses for safety depends on the project. The next highest opinion was that the expenses for safety should be in between 2 3%. Nearly 17.9% of the respondents have this perception.

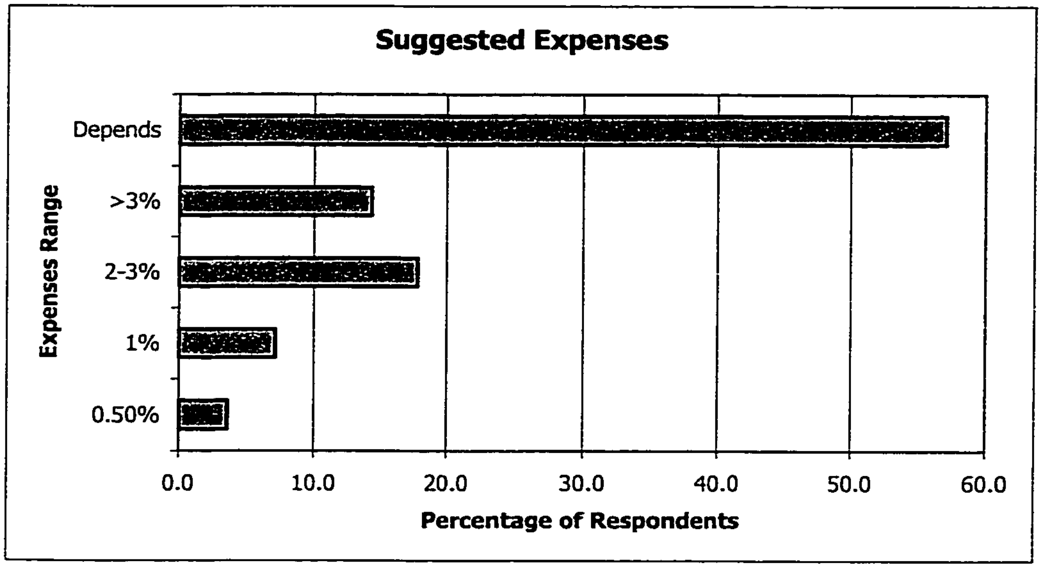

Figure 4.2-5: Suggested Expenses for Safety

4.2.5 Effect of TQM Implementation

To know what role Total Quality Management (TQM) can play in safety, project managers were asked to give their view on the effect of TQM implementation on safety. Few of the respondents were even responsible for quality along other managerial responsibilities. The project managers were asked to give their degree of agreement with the view that, implementation of TQM can help reduce accidents. Almost all of the respondents agree that the implementation of TQM can help reduce accidents. About 50% strongly agree with this view. Only 3.6% of the respondents strongly disagree with this view. Another 3.6% of the respondents do not know about the effect of implementation of TQM.

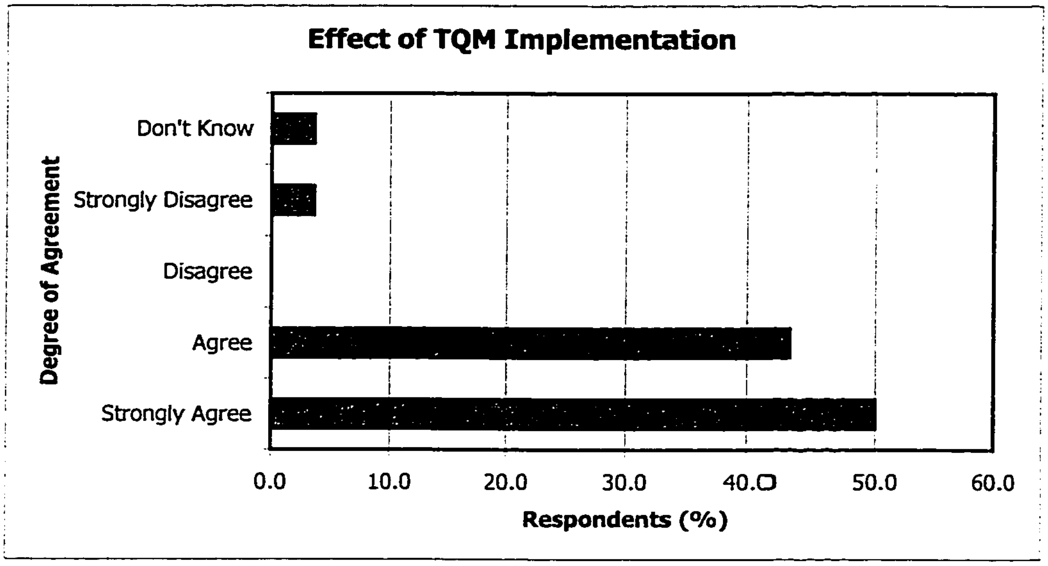

Figure 4.2-6: Effect of TQM Implementation

4.3 Safety Professional's Perception

Safety professional, safety engineer or supervisors, were requested to give their degree of agreement on factors related to general issue of safety. They were asked about adequacy of funds allocated, knowledge of safety regulations, adequacy of current safety regulations and need for safety professionals to have knowledge of construction technology. They were asked to rate these factors from strongly agree to don't know.

4.3.1 Years of Experience

All the respondents have sufficient experience to coin their view on safety related issues. More than 82% of the respondents have over 2 years of experience as safety professional. About 50% have experience between 2-5 years. One fourth of the respondents have experience ranging 5-10 years. None of the safety professional has experience above 15 years. Only about 7.2% have experience between 10-15 years.

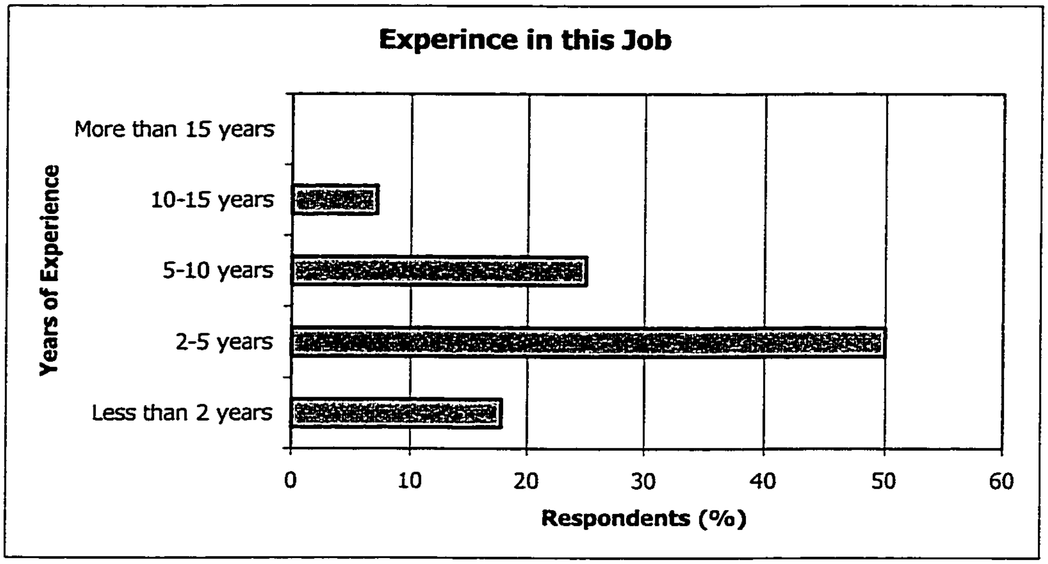

Figure 4.3-1

4.3.2 Allocation of Funds

Safety professionals were requested to give their degree of agreement related to allocation of funds for safety. Majority of the safety professionals agree that the funds allocated for safety are adequate. More than 60% of the respondents agree that funds are adequate and nearly 28.5% strongly agree. Only 7.14% of the safety professionals disagree and says funds are not adequate.

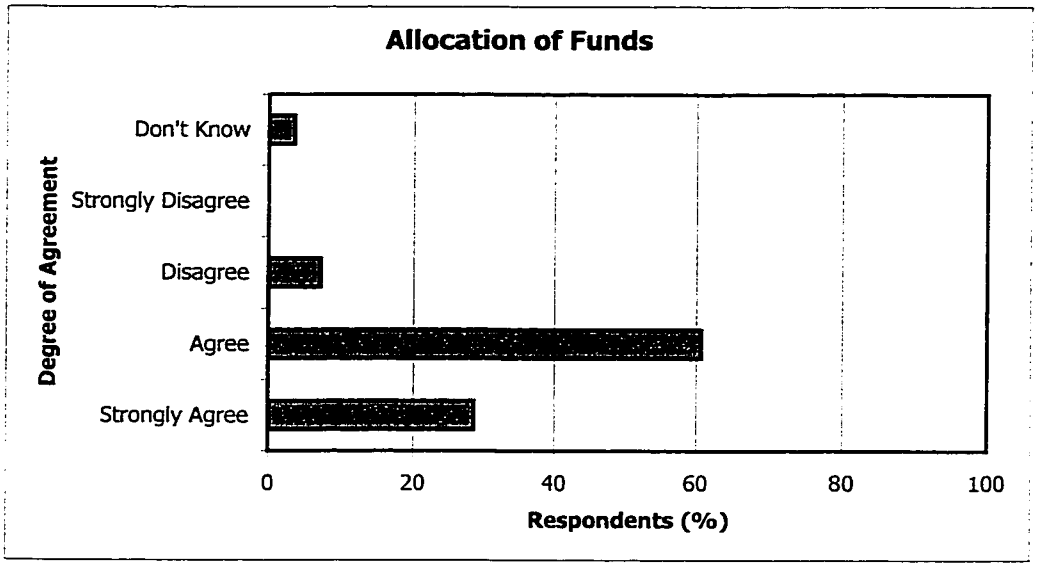

Figure 4.3-2: Allocation of Funds

4.3.3 Worker's Lack Safety Knowledge

To know the perception of the safety professional regarding worker's safety knowledge, they were asked to give their degree of agreement with the view that "accidents are caused as worker's lack safety knowledge. Most of the respondents have the view that workers are being provided with sufficient knowledge.

About 64.28% of the safety professionals disagree that workers lack safety knowledge. Nearly 32.14% of the respondents, agree to some extend that one of cause for accidents is lack of safety knowledge by the workers.

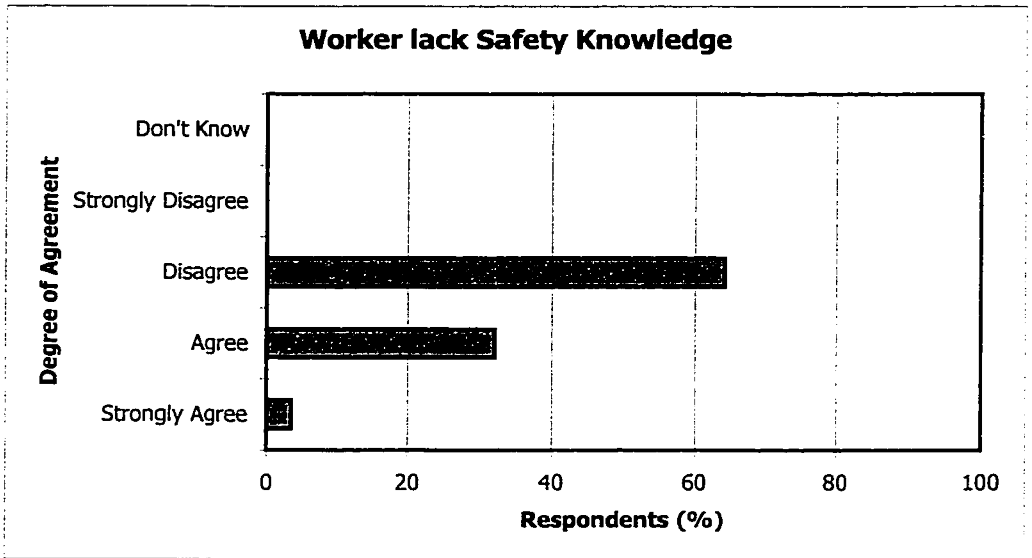

Figure 4.3-3: Workers Lack Safety Knowledge

4.3.4 Knowledge of Safety Regulations

Respondents were asked to give opinion about their knowledge about safety regulation. They were asked to show their agreement with following question "You have knowledge of safety regulation?"

Almost all of the safety professionals agree that they have knowledge of safety regulations. 53.57% of the respondents agree and 39.28% strongly agree. Only 7.14% of the respondents feel that they did not have sufficient knowledge of safety.

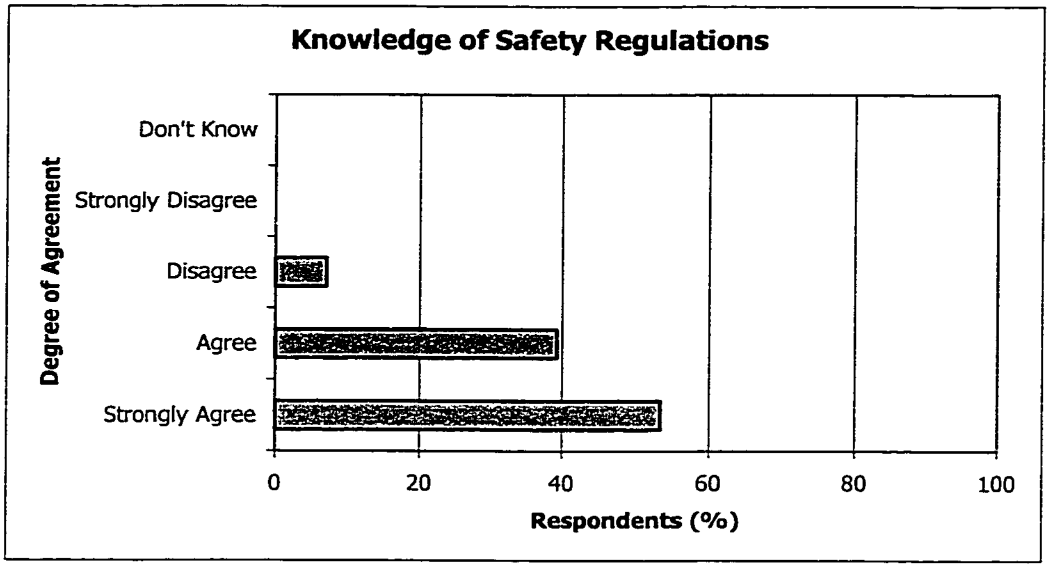

Figure 4.3-4: Knowledge of Safety Regulations

4.3.5 Adequacy of Safety Regulation

Safety professionals were asked, is the current safety regulations adequate? About 53.57% of the respondents agree that the regulations are adequate. Nearly 35.71% of the safety professionals strongly agree that safety regulations are adequate. Just above 7% of the respondents feels that the regulations are not to the mark.

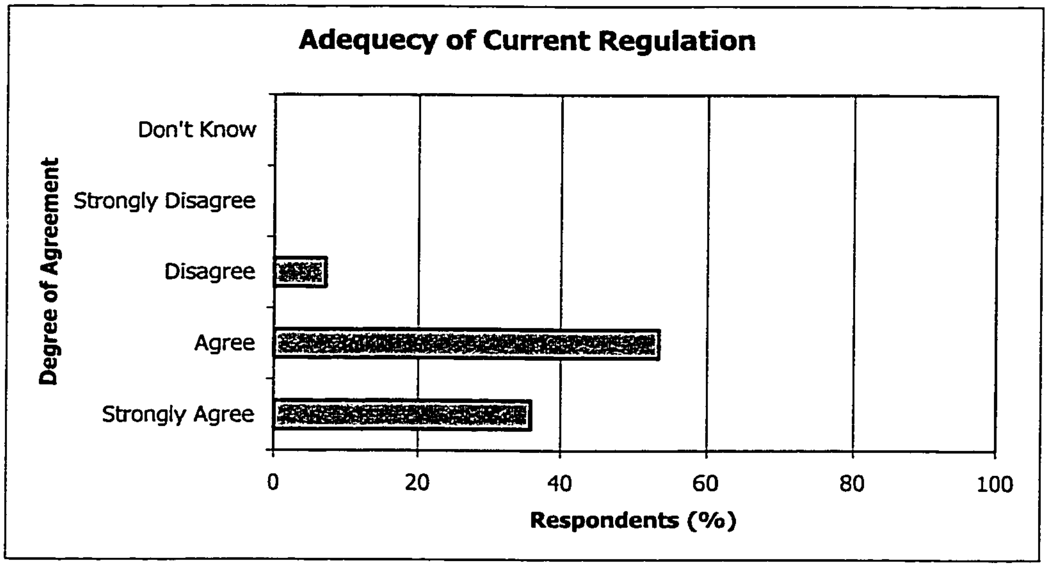

Figure 4.3-5: Adequacy of Current Regulation

4.3.6 Professional's should have Knowledge of Construction Technology

The safety professionals were asked how important is the knowledge of the construction process for the safety engineers. The question asked was "In your opinion should the safety professional have knowledge of construction technology?" About 60% of the respondents strongly agree that the safety professionals should have sufficient knowledge of the construction technology and procedures for smoothly carrying out their responsibilities. Around 30% of the respondents agree that, the professionals should have knowledge of construction technology.

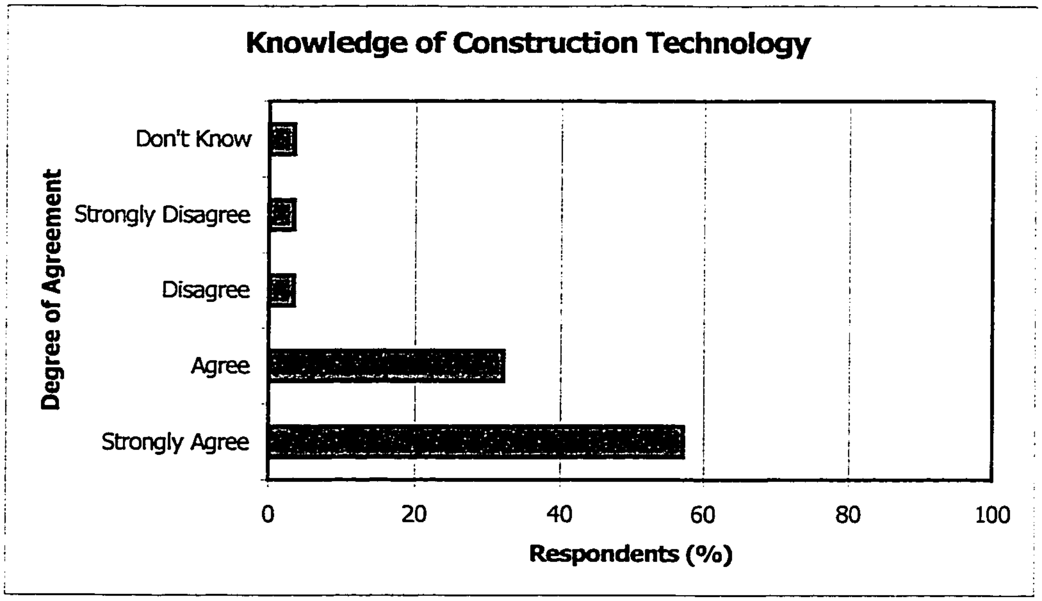

Figure 4.3-6: Safety Professional should have Knowledge of Construction

CHAPTER 5

ASSESSMENT OF SAFETY PERFORMANCE

5.1 Introduction

Safety climate is a specific form of organizational climate, which describes individual perception of the value of safety in the work environment. There are number of factors which are components of safety climate. These factors include: management concern for employee well-being. Management and organizational practices, adequacy of training, provision of safety equipment, quality of safety management system, communication, employee involvement in workplace safety, allocation of funds for safety, etc.

There were several factors, which can help predict safety climate in any organization. There were factors related specifically to the management, which were asked to the project managers in this survey. Questions to know the effects of factors specific to the site safety and management support were asked to the safety professionals. Thirty-seven questions were asked to know the effect of nine different factors related to safety climate. Sixteen questions were asked to project managers to know the effect of four factors, which were concerned with the management. Twenty-one questions were asked to the safety professional to know the effect of five factors specific to safety climate. Factors in the two groups are shown in the table 5.1-1.

Table 5.1-1: Factors for Study

Project Manager	Safety Professional
Administration	Safety Meetings
Management Support	Inspection & Investigation
Planning Meetings	Safety Training
Management Safety Policy	Record Keeping
	Medical & Welfare Facilities

5.2 Evaluation of Safety Factors

To assess the safety climate, project manager's and safety professional's perception about the above nine factors was collected by means of administrating questionnaires. Thirty-seven questions were asked in nine domains (factors). Professionals were requested to respond on a five-point scale ranging from "Always/Yes"(4) to "Never/No"(0).

Four items assessed the administrative system. Example items "Does you firm use safety program or manual" and "Does your firm have a separate safety department". Five items were used to assess the management support factors. Some of the example questions are "Does you top management is concerned about safety" and "Does your firm provide safety awards". Three items were used to assess the planning factors of project managers. To assess the management safety policy factor, six items were asked. Questions like "Does the management identifies a need for safety policy" and "Does management communicate this policy to all the employee" were asked to project managers.

Safety meeting factor was assess by asking four questions to the safety professionals. Examples of items are "Do you conduct toolbox meeting on site" and "Does top management personnel attend these meetings". To assess the inspection & investigation factor, five items were used. Some of them are "Does your firm conduct safety inspection", "Does your firm document the unsafe hazards and conditions".

To assess the safety-training factor, safety professionals were asked three questions related to training. Professionals were asked, "Does your firm gives safety training to all employees". Record keeping factor was assess using four items. Some of them are "Does your firm keeps records of injury & illness" and "Are accidents records analyze to determine trends". To assess the medical and welfare facilities, safety professionals were asked five items. Items include "Are there adequate facilities for first aid" and "are there arrangements for medical advice".

Respondents were asked some general questions about their experience and about the nature of their job. In the second part of the questionnaire, respondents were asked about these factors. Questions were scored as

Table 5.2-1: Quantitative values for Responses

Always/Yes	4-Points
Mostly	3-Points
Sometimes	2-Points
Rarely	1-Points
Never/No	0-Points

The average value and importance index of each of the safety item are calculated and added to get the average value and importance index for the nine safety factors. The method of calculating average value and importance index is shown in the Table 5.2-2.

Table 5.2-2: Method of Calculating Importance Index

S.No	Safety Factor	4 Always/Yes	3 Mostly	2 Sometimes	1 Rarely	0 Never/No
		Number of Responses				
12	Management give adequate support & resource	5	3	4	0	0

$$FS = \frac{((4\ x\ No.of\ A) + (3\ x\ No.of\ M) + (2\ x\ No.of\ S) + (1\ x\ No.of\ R) + (0\ x\ No.of\ N))}{\sum \mathrm{Re}sponses}$$

$$\text{Factor Score} = \frac{((5x4) + (3x3) + (4x2) + (0x1) + (0x0))}{(5+3+4+0+0)} = 3.08$$

Importance Index = (Factor Score/4) X 100

Importance Index = 3.08/4 X 100 = 77.1%

5.2.1 Factors Identified by Primary Industries

The factor score (FS) and important index for all the industries in primary industry category were calculated and shown in Table 5.1-2. All the nine factors are rank as per the importance index. The top factors Identified by primary industries are “Management safety policy”, “Medical & welfare facilities” and “Record Keeping” all these three factors have importance index of 96.354%.

The safety factors can be classified into five categories based on the range of importance index. Factors with importance index ranging from 100-95% are classified as most important. Importance index range from 95 to 90% is categorized as very important. Factors with importance index ranging from 90 to 85% are categorized as important and factors with importance index from 85% to 75% are classified as less important. All factors with importance index less than 75% are classified as not important.

Table 5.2-3: Safety Factors – Primary Industries

Primary Industries													
		Number of Responses											
Ranks	**Safety Factors**	**Always**	**Weighted Score**	**Mostly**	**Weighted Score**	**Sometimes**	**Weighted Score**	**Rarely**	**Weighted Score**	**Never**	**Weighted Score**	**Factor Score**	**Importance Index**
		4		**3**		**2**		**1**		**0**			
1	Safety Policy	41	164	7	21	0	0	0	0	0	0	3.854	96.354
2	Medical Facilities & Welfare	35	140	4	12	1	2	0	0	0	0	3.850	96.250
3	Record keeing	27	108	5	15	0	0	0	0	0	0	3.844	96.094
4	Administrative	27	108	3	9	2	4	0	0	0	0	3.781	94.531
5	Inspection & Investigation	26	104	5	15	1	2	0	0	0	0	3.781	94.531
6	Mnagement Support	31	124	7	21	1	2	1	1	0	0	3.700	92.500
7	Planning Meeting	19	76	4	12	2	4	0	0	0	0	3.680	92.000
8	Safety Training	17	68	3	9	3	6	1	1	0	0	3.500	87.500
9	Safety Meeting	10	40	14	42	8	16	0	0	0	0	3.063	76.563

5.2.2 Factors Identified by Secondary Industries

In secondary industry category, "Medical & welfare facilities" and "Record keeping" were on the top with importance index of 96.2%. The next factor was "Inspection & investigation" with importance index of 94.53%.

Table 5.2-4: Safety Factor - Secondary Industry

Secondary Industries													
		Number of Responses										Factor Score	Importance Index
Ranks	Safety Factors	Always 4	Weighted Score	Mostly 3	Weighted Score	Sometimes 2	Weighted Score	Rarely 1	Weighted Score	Never 0	Weighted Score		
1	Medical Facilities & Welfare	19	76	14	42	3	6	1	1	3	0	3.850	96.250
2	Record keeing	16	64	8	24	6	12	2	2	0	0	3.844	96.094
3	Inspection & Investigation	22	88	8	24	0	0	2	2	0	0	3.781	94.531
4	Safety Policy	32	128	10	30	5	10	1	1	0	0	3.521	88.021
5	Safety Training	15	60	2	6	2	4	2	2	0	0	3.500	87.500
6	Administrative	24	96	3	9	0	0	3	3	2	0	3.375	84.375
7	Planning Meeting	17	68	2	6	2	4	1	1	2	0	3.292	82.292
8	Mnagement Support	19	76	8	24	7	14	3	3	1	0	3.079	76.974
9	Safety Meeting	12	48	10	30	6	12	2	2	1	0	2.968	74.194

5.2.3 Factors Identified by Support Industries

The factors identified by the support industries are shown in Figure 5.2-5. The top factor in this category is "Medical Facilities & Welfare" with importance index of 95.33%. The next factors, which received importance index values of 88.88% and 88.19%, are "Safety Training" and "Safety Policy". The fo!lowing factors are "Inspection & Investigation" and "Safety Meetings", with importance indexes of 85.93% and 85.54%.

Table 5.2-5: Safety Factor   Support Industry

Support Industries													
		Number of Responses											
Ranks	Safety Factors	Always 4	Weighted Score	Mostly 3	Weighted Score	Sometimes 2	Weighted Score	Rarely 1	Weighted Score	Never 0	Weighted Score	Factor Score	Importance Index
1	Medical Facilities& Welfare	48	192	11	33	0	0	0	0	0	0	3.814	95.339
2	Safety Training	23	92	10	30	3	6	0	0	0	0	3.556	88.889
3	Safety Policy	46	184	18	54	8	16	0	0	0	0	3.528	88.194
4	Inspection& Investigation	25	100	19	57	4	8	0	0	0	0	3.438	85.938
5	Safety Meeting	48	192	24	72	9	18	2	2	0	0	3.422	85.542
6	Record keeing	27	108	14	42	7	14	0	0	0	0	3.417	85.417
7	Mnagement Support	35	140	16	48	7	14	1	1	2	0	3.328	83.197
8	Administrative	26	104	11	33	6	12	0	0	5	0	3.104	77.604
9	Planning Meeting	14	56	11	33	11	22	0	0	0	0	3.083	77.083

5.3 Ranking of Safety Factors

All the nine factors were ranked on the bases of importance index in three categories. These ranks are varying for primary, secondary and support, as shown in Table 5.3-1. Mean ranks of all the three industries were calculated and overall ranking assigned to these factors, as shown in Table 5.4-1.

Table 5.3-1: Ranking of Safety Factors

S.No	Safety Factors	Primary		Secondary		Support	
		Factor Score	Rank	Factor Score	Rank	Factor Score	Rank
1	Administrative	3.781	4	3.375	6	3.104	8
2	Mnagement Support	3.7	6	3.079	8	3.328	7
3	Planning Meeting	3.68	7	3.292	7	3.083	9
4	Safety Policy	3.854	1	3.521	4	3.528	4
5	Safety Meeting	3.063	9	2.968	9	3.422	5
6	Inspection& Investigation	3.781	5	3.781	3	3.438	4
7	Safety Training	3.5	8	3.5	5	3.556	2
8	Record keeing	3.844	3	3.844	2	3.417	6
9	Medical Facilities& Welfare	3.85	2	3.85	1	3.814	1

5.4 Analysis for Agreement of Ranks

The Kendall coefficient of concordance (W) is a statistic, which can be a good measure to know how good an agreement or association is among sets of rankings. The coefficient varies between 0 and 1 regardless of the number of sets of rankings. A coefficient of W =1 indicates a perfect agreement and coefficient of W = 0 indicates no agreement or association. Kendall coefficient of concordance is calculated using the following formula;

$$W = \frac{\sum_{i=1}^{i=n}(R_i - R)^2}{n(n^2-1)/12} \quad \text{(Kaming, 1996)}$$

Where ;

n = No. of Factors or criteria = 9

R_i = the mean of ranks assigned to each factor, example $R_1 = (4+6+8)/3 = 6$

R = Grand mean or average of all the means assigned to all factors.

$$R = \frac{\sum_{i=1}^{i=9} R_i}{n}, \quad R = (R_1+R_2+R_3+R_4+\ldots R_n)/n$$

In this case, $R = (R_1+R_2+R_3+R_4+R_5+R_6+R_7+R_8+R_9)/9$

$R = (6+7+7.667+3+7.667+4+5+3.667+1.33)/9 = 5.037$

$$\sum_{i=1}^{i=9}(R_i - R)^2 = \sum_{i=1}^{i=9}(R_i - 5.037)^2 = (6-5.037)^2 + (7-5.037)^2 + (7.667-5.037)^2 + (3-5.037)^2 + (7.667-5.037)^2 + (4-5.037)^2 + (5-5.037)^2 + (3.667-5.037)^2 + (1.333-5.037)^2 = 39.43$$

$$\text{Kendall coefficient of concordance: } W = \frac{39.43}{9\left((9^2-1)/12\right)} = 0.657$$

Ranks for each of the safety factor were calculated and compared for different categories of industries., using Kendall Concordance analysis. The mean of ranks and overall ranking assigned to each factor was calculated and presented in Table 5.4-1.

Table 5.4-1:Overall Ranking of Safety Factors

S.No	Safety Factors	Primary Industry Ranks	Secondary Industry Ranks	Support Industry Ranks	Sum of Ranks	Mean of Ranks	Overall Ranking
1	Administrative	4	6	8	18	6.000	6
2	Mnagement Support	6	8	7	21	7.000	7
3	Planning Meeting	7	7	9	23	7.667	9
4	Safety Policy	1	4	4	9	3.000	2
5	Safety Meeting	9	9	5	23	7.667	8
6	Inspection & Investigation	5	3	4	12	4.000	4
7	Safety Training	8	5	2	15	5.000	5
8	Record keeing	3	2	6	11	3.667	3
9	Medical Facilities& Welfare	2	1	1	4	1.333	1

5.4.1 Testing of Kendall Coefficient of Concordance

To test the significance and validate the analysis by Kendall coefficient of concordance, Chi-square values are used. Chi-square is a useful tool to test null hypothesis. The null hypothesis, was framed as ranks in three categories of industries are not related. The value of Chi-square will help in rejecting or accepting the null hypothesis.

$$\text{Chi-square, } \chi^2 = K(n-1)W$$

Where;

K = Number of categories or groups

N = Number of factors

W = Kendall Coefficient of concordance

The Kendall coefficient value of W=0.657 expresses the degree of agreement among the ranks for three categories of industries. Since the number of factors (n = 9) is greater than seven, Chi-square value is calculated for K = 3 (Number of groups), n = 9 (number of Safety Factors), and W = 0.657;

$$\chi^2 = 3(9-1)*0.657 = 15.77$$

Referring to the critical values of Chi-square distribution table (Appendix) with a degree of freedom (DF) = 9-1 = 8, the critical Chi-square value (χ^2) = 15.51 is less than the observed value of χ^2 in a probability of occurrence under the null hypothesis of $P<0.05$.

It could be concluded with confidence that the level of agreement among the ranks of these three industries is high. The high probability under null hypothesis associated with observed value of W allows rejecting the null hypothesis; that the rankings of these three categories of industries are unrelated to each other. This shows that there is agreement among the ranks of these three-industry types.

5.5 Safety Assessment

To assess the safety performance, of the industries, performance levels were used. The 28 questionnaires received were analyzed to calculate the industry frequency rates, the industry Safety Attitude Score and industry performance level. These performance levels (PL) are calculated by dividing the Safety Attitude Score (SAS) with the frequency rates (FR).

5.5.1 Calculation of Frequency Rate

To measure the safety climate and the safety accomplishment, frequency rates provide a good statistic. It measures the safety performance in terms of number of accidents. Frequency rates are usually used as quantitative indicators to evaluate changes, measure safety progress and warn of the potential hazards.

Frequency rates are considered as a tool to access industry's safety performance. It is used to compare accident statistics either within the industry or within the organization. Total injury frequency rate is used in this study, it is the number of all the injuries per million employee-hours worked. It is expressed as:

$$\text{Frequency Rate} = \frac{Total\ No\ .of\ Injuries\ X\ 1{,}000{,}000}{Man - hours.worked}$$

Frequency rates for the three types of industries were calculated and shown in Tables.

5.5.1.1 Primary Industry Frequency Rates

Frequency rates were calculated using the above formula. All of the eight respondents provided information about injury/accident data. The frequency rate in primary industries varies from 0 to 43.11. The average frequency rate was 13.79; only two industries were above this average. The standard deviation for primary frequency rates was 15.92 and variance 253.56. The frequency rates are presented in the Table 5.5-1.

Table 5.5-1 :Frequency Rates-Primary Industry

Frequency Rates-Primary Industry						
Industry No.	Man-Hours	No.Recordable Injuries	No.Lost Time Injuries	No.First Aid Cases	Total Injuries	Frequency Rate
1	300,000	0	0	10	10	33.333
2	1,077,951	1	0	7	8	7.421
3	371,117	3	0	13	16	43.113
4	2,800,000	9	0	18	27	9.643
5	1,139,379	0	0	3	3	2.633
6	2,656,033	0	0	3	3	1.130
7	1,452,200	6	0	13	19	13.084
8	983,051	0	0	0	0	0.000

5.5.1.2 Secondary Industry Frequency Rates

The frequency rate in secondary industries ranges from 0.0 to 86.20. The average frequency rate for secondary industries was 34.83. The standard deviation for secondary industries is 28.64 and the variance is 820.74. The high standard deviation and variance shows that the frequency rates are fluctuating around the mean rates. Table 5.5-2 shows the frequency rates for secondary industries.

Table 5.5-2: Frequency Rate Secondary Industry

Frequency Rates-Secondary Industry						
Industry No.	Man-Hours	No.Recordable Injuries	No.Lost Time Injuries	No.First Aid Cases	Total Injuries	Frequency Rate
1	448,000	0	0	27	27	60.268
2	120,000	1	1	2	4	33.333
3	444,000	0	0	2	2	4.505
4	384,200	0	5	12	17	44.248
5	70,000	0	0	0	0	0.000
6	58,000	0	0	5	5	86.207
7	605,000	2	1	15	18	29.752
8	2,160,000	9	5	30	44	20.370

5.5.1.3 Support Industry Frequency Rates

The frequency rates for the support industries are shown in Table 5.5-3. The average frequency rate for support industries is 89.43. The standard deviation and variance are too high for the support industries. The variance and standard deviation are 147.15 and 21653.16 respectively. The rates are scattered around the mean. The can be attributed to more number of industries with varying sizes and man-hours.

Table 5.5-3: Frequency Rate Support Industry

Frequency Rates-Support Industry						
Industry No.	Man-Hours	No.Recordable Injuries	No.Lost Time Injuries	No.First Aid Cases	Total Injuries	Frequency Rate
1	1,350,371	8	0	5	13	9.627
2	1,775,000	38	17	56	111	62.535
3	224,840	0	0	3	3	13.343
4	370175	11	8	13	32	86.446
5	3,052,000	29	696	60	785	257.208
6	434,429	54	64	88	206	474.186
7	225,000	0	0	5	5	22.222
8	N/A	N/A	N/A	N/A	0	N/A
9	13,595,826	6	6	14	26	1.912
10	1,375,000	0	1	14	15	10.909
11	790,000	2	0	8	10	12.658
12	18,140,359	270	174	149	593	32.690

5.5.2 Safety System Score

The twenty-eight received questionnaires were analyzed and safety system score (SSS) was calculated for each of the three types of industries. Safety system score is the sum of factor scores evaluated by the particular industry.

$$SSS = \sum_{i=1}^{i=n} FSi \text{, where SSS = Safety System Score for particular industry,}$$

FS_i = Factor score for i^{th} factor.

Safety system score for all the participating industries were calculated and presented in Tables 5.5-4 to Table 5.5-6. The average of safety system score for all industries was 3.413. The highest safety system score was 3.94 and the minimum was 1.26.

5.5.2.1 Safety System Score Primary Industry

The safety system scores in the primary industries are consistent. The average score is 3. 66. The standard deviation and variance are 0.27 and 0.07 respectively.

Table 5.5-4: Safety System Scores Primary Industry

Industry No.	Safety System Score
1	3.64
2	3.64
3	3.68
4	3.64
5	3.92
6	3.79
7	3.89
8	3.06

5.5.2.2 Safety System Score Secondary Industry

The safety system score in secondary industry are varying. The average score was 3.25. The standard deviation and variance are 0.84 and 0.71 respectively. Only one industry has very low score of 1.26. The average after eliminating this low score was 3.53. The standard deviation and variance also changes drastically, with values 0.26 and 0.07. This shows that the safety system scores are consistent in secondary industries also.

Table 5.5-5: Safety System Scores Secondary Industry

Industry No.	Safety System Score
1	3.69
2	3.50
3	3.52
4	3.08
5	3.94
6	1.26
7	3.48
8	3.53

5.5.2.3 Safety System Score Support Industry

There were twelve respondents in the support category. These entire questionnaires were analyzed and safety system scores were calculated as shown in Table 5.5-6. The average safety system score was 3.36. The standard deviation was 0.44 and the variance was 0.2. The score are varying with minimum score of 2.63 and maximum of 3.83.

Table 5.5-6: Safety System Scores   Support Industry

Industry No.	Safety System Score
1	3.39
2	3.52
3	2.96
4	3.79
5	3.79
6	2.75
7	2.63
8	3.54
9	3.83
10	3.52
11	2.84
12	3.76

5.5.3 Performance Level Index

To measure the industry safety performance and to give it a numerical value, Safety performance levels index were calculated. Safety performance level index is calculated by dividing the safety system score with the maximum score of 4 for each industry. The result will be multiplied with 100 to get percentage score.

$$\text{Safety Performance Level Index (SPLI)} = \frac{\text{Safety System Score}}{\text{Maximum Score (4)}} \times 100$$

Based on the performance level index industries are classified as excellent, very good, good, fair and poor. Industries are rating as:

Table 5.5-7: Rating of Performance Level

Performance Level Range	Rating
100 90	Excellent
90 80	Very Good
80 70	Good
70 60	Fair
60 - Below	Poor

5.5.3.1 Primary Industry Performance Level Index

The safety performance level index for all the three industry types were calculated and presented in Tables. Safety performance level index for primary industries are high with the maximum being 97.92 and minimum was 76.57. There is not much variation in performance level index for primary industries. The standard deviation and variance are 6.659 and 44.35 respectively. Only one industry has value less than average. All the industries expect one is rated as excellent.

Table 5.5-8: Performance Level Index Primary Industry

Primary Industry			
S.No	**Safety System Score**	**Frequency Rate**	**Safety Performance Level Index**
1	3.64	33.33	91.11
2	3.64	7.42	90.93
3	3.68	43.11	91.94
4	3.64	9.64	91.11
5	3.92	2.63	97.92
6	3.79	1.13	94.86
7	3.89	13.08	97.36
8	3.06	0.00	76.57

5.5.3.2 Secondary Industry Performance Level Index

The safety performance level index for secondary industries group varies. The average performance level index was 81.25. The standard deviation and variance for this group are 21.02 and 441.9 respectively. Two of the industries were rated as excellent; four industries were rated as very good. One of the industries was rated as good and one more was rated as poor.

Table 5.5-9: Performance Level Index Secondary Industry

Secondary Industry			
S.No	**Safety System Score**	**Frequency Rate**	**Safety Performance Level Index**
1	3.69	60.3	92.27
2	3.50	33.3	87.5
3	3.52	4.5	88.1
4	3.08	44.2	76.99
5	3.94	0	98.61
6	1.26	86.2	31.39
7	3.48	29.8	86.99
8	3.53	20.4	88.15

5.5.3.3 Support Industry Performance Level Index

For the support industries group the variation in performance level index is low as compared to the secondary industries group. The maximum score was 9.56 and minimum was 65.8. The average performance level index was 84.0, the standard deviation was 11.1 and the variance was 123. Four industries were rated as excellent; four were rated as very good. Two industries were rated as good and last two were rated as fair.

Table 5.5-10: Performance Level Index   Support Industry

Support Industry			
S.No	**Safety System Score**	**Frequency Rate**	**Safety Performance Level Index**
1	3.39	9.63	84.8
2	3.52	62.5	88.1
3	2.96	13.3	74
4	3.79	86.4	94.6
5	3.79	257	94.8
6	2.75	474	68.7
7	2.63	22.2	65.8
8	3.54	0	88.5
9	3.83	1.91	95.6
10	3.52	10.9	88
11	2.84	12.7	71.1
12	3.76	32.7	94.1

CHAPTER 6

ASSESSMENT OF SAFETY LEVEL

6.1 Walkthrough Inspection

The immediate causes of accidents include unsafe acts and conditions. Unsafe conditions are physical condition, which have to be corrected from as and when detected to prevent accidents. To identify unsafe conditions and practices, safety performance of the industrial projects should be carried out. Unsafe conditions are detected on any project by performing regular inspection. These types of inspections are carried out using checklist.

The survey inspections in this study were performed in Jubail Industrial city. The subject industries include three type of industries, 1) Primary 2) Secondary and 3) Support, as per Royal Commission for Jubail. There were eight (8) Primary industries, eight (8) Secondary industries and twelve (12), Light Manufacturing & Support industries.

The checklist used in this research is shown in appendix. These checklists include items, which are perceived to be important from the safety point of view on an industrial project. The checklist consists of thirteen (13) divisions and 63 items distributed among the different divisions.

6.2 Checklist Analysis

The checklist items were evaluated as "Yes", "No" or "N/A" depending on its existence on the project. Each "Yes" was given a score of 1 and each "No" was given a score of "-1", and each item, which was not applicable, was assigned 0 to eliminate from calculations. The Division Score (DS) was calculated by the following equation;

$$\text{Division Score (DS)} = \frac{\sum\left[No.of\text{"}Yes\text{"}\,X(1) + No.of\text{"}No\text{"}\,X(-1)\right]}{No.\ of\ applicable\ items}$$

Items, which were not applicable for a particular industry, were ignored and not used in calculation of division score. Industry's Safety Level (SL) was then calculated, which is the average of all the applicable division scores. Following scale was used to assigned ranks to industries:

Table 6.2-1: Rating of Safety Level

Safety Level Range	Rating
-1.00 to 0.19	Poor
0.20 to 0.39	Fair
0.40 to 0.59	Good
0.60 to 0.79	Very Good
0.80 to 1.00	Excellent

6.3 Calculation of Safety Levels

Safety level score for all the industries was calculated separately in three different categories, Primary, Secondary and Support. The Industry Safety Level (SL) is the average of all the applicable division score for a particular industry. Rates were assigned based on the above rating scale. The rating system is the same used in the literature, but adjusted to suit the used scale of division scores. The scale used in this study for assigning division is scores is 1 to 1. (Jannadi & Assaf, 1998)

6.3.1 Safety Level Primary Industries

Table 6.3-1 shows the safety level in primary industry group. The highest was 0.88 (Excellent) and the lowest was 0.56 (Good). The safety level in this group of industries was consistent. Five of the industries in this group were rated as Excellent, two were rated as Very Good and one was rated as Good. The standard deviation and variance were 0.13 and 0.02 respectively. The average safety level was 0.80 for primary industry group.

Table 6.3-1: Descriptive Statistics

Industry Category	Average Safety Level	Standard Deviation	Variance
Primary	0.80	0.13	0.02
Secondary	0.61	0.21	0.04
Support	0.48	0.17	0.03

Table 6.3-2: Safety Level Primary Industry

Primary Industries		
Industry No.	Safety Level	Rating
1	0.80	Excellent
2	0.87	Excellent
3	0.87	Excellent
4	0.56	Good
5	0.78	Very Good
6	0.88	Excellent
7	0.63	Very Good
8	0.84	Excellent

6.3.2 Safety Level Secondary Industries

The safety level in secondary industry group varied widely. The average safety level was 0.61, with standard deviation and variance being 0.21 and 0.04 respectively. Two industries in this group were rated as Very Good, three were rated as Good, two were rated as Fair, and one was rated as Poor. This variation is due to different sizes of industries in the group. None of the industries was rated as Excellent. The safety level for secondary industry group is shown in Table 6.3-2.

Table 6.3-3: Safety Level Secondary Industry

Secondary Industries		
Industry No.	Safety Level	Rating
1	0.48	Good
2	0.65	Very Good
3	0.48	Good
4	0.24	Fair
5	0.48	Good
6	0.19	Fair
7	0.11	Poor
8	0.73	Very Good

6.3.3 Safety Levels Support Industries

The safety level in support industry group is consistent when compared to secondary industry group. The highest safety level was 0.87 (Very Good) and lowest was 0.20 (Fair). The average safety level was 0.48, the standard deviation was 0.17 and the variance was 0.03. There were two industries in this group, which were rated Very Good, five were rated as Good and four were rated as Fair. The safety level for support industry group is shown in Table 6.3-3.

Table 6.3-4: Safety Level Support Industry

Support Industries		
Industry No.	Safety Level	Rating
1	0.33	Fair
2	0.49	Good
3	0.53	Good
4	0.20	Fair
5	0.58	Good
6	0.87	Very Good
7	0.49	Good
8	0.67	Very Good
9	0.52	Good
10	0.43	Good
11	0.26	Fair
12	0.39	Fair

CHAPTER 7

CORRELATION OF PERFORMANCE LEVEL AND SAFETY LEVEL

7.1 Correlation between Performance Level and Safety Level

Performance level index was calculated based on the data gathered by administrating questionnaires. The performance level indicates safety climate prevailing in these industries. Safety level scores were calculated based on the data gathered from inspection checklist. These scores indicate the physical aspect of safety. To study the relationship between the safety climate and the physical aspects of safety, it is required to know the association between the performance level and the safety level.

Studying relations between variables is very important; it helps in understanding how variables are related to one another. A correlation coefficient indicates both the direction and the strength of the relation between two variables, in this case Performance level and safety level. The sign of the coefficient (+ or -) indicates the type of relation, positive or negative. The value of the coefficient indicates the strength of the relation- when the relation is perfect the value is 1.0 and 0.0 when there is no systematic relation.

The performance level and safety level are based on different scales, the best method of calculating correlation will be the Pearson r or Product-Moment correlation coefficient, usually denoted as r. The formula for calculating r is;

$$r = \frac{\sum Z_x Z_y}{N}$$

$$Z_x = \frac{X - M_x}{\sigma_x}$$

$$Z_y = \frac{Y - M_y}{\sigma_y}$$

$$\sigma_x = \frac{(X - M_x)^2}{N}$$

$$\sigma_y = \frac{(Y - M_y)}{N}$$

M_x = the average of values of x

N = Number of items (industries)

X = Variable value (Performance Level)

Y = Variable value (Safety Level)

Z = deviation score lies above or below the mean score

Z_x = Value of deviation in x distribution (performance Level)

Z_y = values of deviation in y distribution (Safety level)

σ_x = the standard deviation of value of x

σ_y = the standard deviation of value of y

The r-value depends on the Z score; the Z score for any group indicates the location of that score in a distribution of scores. The correlation coefficient shows precisely how a score deviates from the mean score.

The calculation for the Pearson r correlation coefficient between performance level index (SPLI) and safety level (SL) in the three types of industries is shown in Tables 7.1-1 to 7.1-3.

Table 7.1-1: Correlation of Performance and Safety Level Primary Industry

No	PL (X)	$(X - M_x)$	$(X - M_x)^2$	SL (Y)	$(Y - M_y)$	$(Y - M_y)^2$	σ_x	σ_y	Z_x	Z_y	Z_xZ_y	r
1	91.11	-0.36	0.13	0.80	0.01	0.00	6.66	0.13	-0.05	0.05386	-0.00295	-0.10789
2	90.93	-0.55	0.30	0.87	0.07	0.01	6.66	0.13	-0.08	0.53443	-0.04412	
3	91.94	0.47	0.22	0.87	0.07	0.01	6.66	0.13	0.07	0.55640	0.03916	
4	91.11	-0.36	0.13	0.56	-0.24	0.06	6.66	0.13	-0.05	-1.78877	0.09793	
5	97.92	6.44	41.49	0.84	0.04	0.00	6.66	0.13	0.97	0.32161	0.31106	
6	94.86	3.39	11.46	0.96	0.16	0.03	6.66	0.13	0.51	1.20517	0.61267	
7	97.36	5.89	34.64	0.63	-0.16	0.03	6.66	0.13	0.88	-1.23406	-1.09063	
8	76.57	-14.90	222.06	0.84	0.05	0.00	6.66	0.13	-2.24	0.35136	-0.78623	
M_x	91.48									Sum	-0.86311	
M_y	0.80											

Table 7.1-2: Correlation of Performance and Safety Level Secondary Industry

No	PL (X)	(X - M_x)	(X - M_x)^2	SL (Y)	(Y - M_y)	(Y - M_y)^2	σ_x	σ_y	Z_x	Z_y	Z_xZ_y	r
1	92.27	11.02	121.41	0.72	0.11	0.01	21.02	0.21	0.52	0.54121	0.28366	0.283106
2	87.50	6.25	39.06	0.77	0.17	0.03	21.02	0.21	0.30	0.81180	0.24135	
3	88.10	6.85	46.95	0.80	0.20	0.04	21.02	0.21	0.33	0.94774	0.30890	
4	76.99	-4.26	18.14	0.36	-0.24	0.06	21.02	0.21	-0.20	-1.16266	0.23556	
5	98.61	17.36	301.41	0.70	0.09	0.01	21.02	0.21	0.83	0.45284	0.37397	
6	31.39	-49.86	2486.13	0.51	-0.10	0.01	21.02	0.21	-2.37	-0.46220	1.09624	
7	86.99	5.74	32.96	0.25	-0.36	0.13	21.02	0.21	0.27	-1.73534	-0.47388	
8	88.15	6.90	47.58	0.73	0.13	0.02	21.02	0.21	0.33	0.60661	0.19905	
Mx	81.25									Sum	2.26485	
My	0.61											

Table 7.1-3: Correlation of Performance and Safety Level Support Indusry

No	PL (X)	(X - M_x)	(X - M_x)^2	SL (Y)	(Y - M_y)	(Y - M_y)^2	σ_x	σ_y	Z_x	Z_y	Z_xZ_y	r
1	84.81	0.80	0.64	0.33	-0.15	0.02	11.10	0.16	0.07	-0.89304	-0.06427	-0.19477
2	88.10	4.09	16.69	0.49	0.02	0.00	11.10	0.16	0.37	0.13503	0.04972	
3	74.03	-9.99	99.77	0.53	0.06	0.00	11.10	0.16	-0.90	0.33840	-0.30463	
4	94.63	10.61	112.64	0.20	-0.27	0.07	11.10	0.16	0.96	-1.64397	-1.57248	
5	94.81	10.80	116.61	0.58	0.11	0.01	11.10	0.16	0.97	0.65576	0.63819	
6	68.66	-15.36	235.89	0.78	0.30	0.09	11.10	0.16	-1.38	1.85592	-2.56891	
7	65.79	-18.23	332.30	0.49	0.02	0.00	11.10	0.16	-1.64	0.12609	-0.20714	
8	88.52	4.50	20.27	0.67	0.20	0.04	11.10	0.16	0.41	1.19885	0.48645	
9	95.65	11.63	135.30	0.52	0.05	0.00	11.10	0.16	1.05	0.28030	0.29384	
10	87.96	3.95	15.58	0.43	-0.04	0.00	11.10	0.16	0.36	-0.25609	-0.09109	
11	71.11	-12.91	166.54	0.26	-0.21	0.04	11.10	0.16	-1.16	-1.27298	1.48052	
12	94.12	10.10	102.09	0.39	-0.09	0.01	11.10	0.16	0.91	-0.52428	-0.47741	
Mx	84.02									Sum	-2.33722	
My	0.47											

Table 7.1-4: Correlation of Performance and Safety Level –All Industry

No	PL (X)	(X - M_x)	(X - M_x)^2	SL (Y)	(Y -M_y)	(Y - M_y)^2	σ_x	σ_y	Z_x	Z_y	Z_xZ_y	r
1	91.11	5.75	33.11	0.80	0.20	0.04	13.90	0.21	0.41	0.94372	0.39074	0.197435
2	90.93	5.57	31.01	0.87	0.27	0.07	13.90	0.21	0.40	1.24439	0.49865	
3	91.94	6.59	43.39	0.87	0.27	0.07	13.90	0.21	0.47	1.25814	0.59637	
4	91.11	5.75	33.11	0.56	-0.04	0.00	13.90	0.21	0.41	-0.20915	-0.08660	
5	97.92	12.56	157.74	0.84	0.24	0.06	13.90	0.21	0.90	1.11124	1.00429	
6	94.86	9.50	90.33	0.96	0.35	0.13	13.90	0.21	0.68	1.66405	1.13802	
7	97.36	12.00	144.10	0.63	0.03	0.00	13.90	0.21	0.86	0.13791	0.11913	
8	76.57	-8.78	77.14	0.84	0.24	0.06	13.90	0.21	-0.63	1.12985	-0.71408	
9	92.27	6.91	47.77	0.72	0.11	0.01	13.90	0.21	0.50	0.53652	0.26683	
10	87.50	2.14	4.59	0.77	0.17	0.03	13.90	0.21	0.15	0.79955	0.12329	
11	88.10	2.74	7.53	0.80	0.20	0.04	13.90	0.21	0.20	0.93169	0.18401	
12	76.99	-8.37	70.00	0.36	-0.24	0.06	13.90	0.21	-0.60	-1.11976	0.67413	
13	98.61	13.25	175.67	0.70	0.10	0.01	13.90	0.21	0.95	0.45061	0.42976	
14	31.39	-53.97	2912.57	0.51	-0.09	0.01	13.90	0.21	-3.88	-0.43887	1.70431	
15	86.99	1.63	2.67	0.25	-0.36	0.13	13.90	0.21	0.12	-1.67644	-0.19707	
16	88.15	2.79	7.79	0.73	0.13	0.02	13.90	0.21	0.20	0.60009	0.12052	
17	84.81	-0.54	0.29	0.33	-0.28	0.08	13.90	0.21	-0.04	-1.30017	0.05074	
18	88.10	2.74	7.53	0.49	-0.11	0.01	13.90	0.21	0.20	-0.50982	-0.10069	
19	74.03	-11.33	128.35	0.53	-0.08	0.01	13.90	0.21	-0.82	-0.35347	0.28817	
20	94.63	9.27	85.98	0.20	-0.40	0.16	13.90	0.21	0.67	-1.87746	-1.25270	
21	94.81	9.46	89.45	0.58	-0.02	0.00	13.90	0.21	0.68	-0.10950	-0.07452	
22	68.66	-16.70	278.88	0.78	0.17	0.03	13.90	0.21	-1.20	0.81314	-0.97713	
23	65.79	-19.57	382.99	0.49	-0.11	0.01	13.90	0.21	-1.41	-0.51670	0.72763	
24	88.52	3.16	9.99	0.67	0.07	0.00	13.90	0.21	0.23	0.30801	0.07007	
25	95.65	10.29	105.90	0.52	-0.08	0.01	13.90	0.21	0.74	-0.39815	-0.29483	
26	87.96	2.61	6.79	0.43	-0.17	0.03	13.90	0.21	0.19	-0.81050	-0.15198	
27	71.11	-14.25	202.95	0.26	-0.34	0.12	13.90	0.21	-1.03	-1.59225	1.63224	
28	94.12	8.76	76.79	0.39	-0.22	0.05	13.90	0.21	0.63	-1.01667	-0.64110	
Mx	85.36									Sum	5.52818	
My	0.60											

7.1.1 Interpreting the Coefficient of Correlation r

The value of r indicates the strength of relation between two variables, when the relation is "perfect" the value of r is 1.00; value of 0.0 indicates that there is no systematic relation between two variables. For interpreting values of r, like r = -0.35 or r=0.19 and to know the strength, values are r are not enough. For this purpose, values of r^2, square of the coefficient of correlation are to be used. Square of the coefficient of correlation (r^2)

indicates the strength of the association. One of the purposes of calculating r is to predict one variable based on the values of another. The prediction error can be used to assess the strength of the association. The values of r, which reduces the error, are having high correlation, so with this the strength can be judged. The values of r for different values of reduction in prediction error variance are given in the Table 7.1-5.

Table 7.1-5: Relation between Value of r and the Accuracy of Predicting Y from X

Value of r	Reduction in Prediction Error Variance
1.00	100% (perfect)
0.90	81%
0.80	64%
0.70	49%
0.60	36%
0.50	25%
0.40	16%
0.30	9%
0.20	4%
0.10	1%
0.00	0%(Poorest)

The correlation coefficient r for the primary industry was found to be r=-0.107. The value of Pearson correlation coefficient r is very low, hence there is no significant relation between the performance level and safety level in the primary industry group. The numerical values of r=0.107, indicates that it can predict the value of performance level based on safety level or visa versa with 1-4% accuracy.

The correlation coefficient r for the secondary industry group was r=+0.283, this value is also low to indicate any association between the performance level and safety level. The numerical value of 0.283 indicates that r can predict values of performance level based on safety level values or visa versa with 4-9% accuracy.

The relationship between the performance level and safety level for the support industry group is r= 0.194. This shows that there is no association in between the two variables, the performance level the safety level. The range of accuracy with which this r-value can predict the performance level with the given safety level is 1-4%.

The overall correlation coefficient for all the three types of industries combined is r=0.1974. This indicates that there is no significant association between the performance level and the safety level. These r-values cannot be used to predict the values of one variable from another variable.

CHAPTER 8

CONCLUSIONS AND RECOMMENDATIONS

8.1 Conclusions

In this study twenty-eight industries were studied, eight of them were primary industries, eight were secondary and twelve were support & light manufacturing. Based on the perception survey, analysis of performance level and safety level as discussed in chapters 4, 5,6 and 7 following conclusions are reached.

8.1.1 Perception Surveys

1. Major reasons for accidents on site in project managers' opinion are lack of proper training and organizational culture. According to safety engineers' perception, the workers have been provided with sufficient knowledge about safety and about 64% of the safety professional disagree that the accidents on site are because on lack of knowledge.

2. The responsibility for accidents on site is on all the parties involved in the project. The party that has the main responsibility according to project managers is management.

3. The expenses or funds for safety management vary from industry to industry. The factors, which determine the allocation of funds, are the complexity of project, location, type, process and products produced.

4. Implementing Total quality Management (TQM) can help reduce accidents on site. Quality management system can take care for safety. Majority of respondents feel that, quality and safety should be merged.

5. Majority of the professionals in primary industries agree that the funds allocated for safety are adequate. But in secondary and support industries there are some professionals who feel that the allocation of funds is not sufficient.

6. Knowledge of safety regulation needs improvement. About 60% of the professionals have adequate knowledge, for safe workplace cent percent of the professionals should have adequate knowledge. There is need for new and revised safety regulation, but the professionals feel that, knowledge of regulation is important than merely having them on paper.

8.1.2 Safety Climate

Based on the analysis of performance level index, following conclusions about the safety climate can be reached.

1. Having strong safety policy, good medical and welfare facilities and adequate record keeping methods are the most important factors for primary industry group.

2. The most important factors for secondary group of industries are good medical and welfare facilities, adequate record keeping procedures and proper inspection and investigation methods.

3. For support and light manufacturing industries group, the important factors are safety training, medical and welfare facilities and safety policy.

4. The important factors are mostly common for all the industry groups. These are provision of proper medical and welfare facilities, strong safety policy and adequate inspection and investigation procedures

5. Kendall concordance analysis results and the calculated Chi-square value shows that there is correlation between the ranking of safety factors in all the three type of industries.

6. The safety performance level index for support industries vary greatly. The maximum value of performance level index was 95.65 (Excellent) and the minimum was 65.80 (Poor). Four of the industries were rated as excellent and two were rated as fair.

7. For secondary group of industries, the safety performance level index values are mostly consistent, with one exception. The average value was 81.25. The average will change if one of the exceptionally low values is eliminated. The average will

be 88.37. Two of the industries were rated as excellent, four were rated as very good, one was rated as good and one more was rated as fair.

8. The performance level index for primary industries is consistent with the average value being 91.48. The average for primary industry group is above the industry average of 85.58. All the industries except one were rated as excellent.

9. The performance level varies much in the secondary industries as compared to the support. This can be attributed to one unexceptionally low value and the way the industries are classified.

10. The average total frequency rate for all the industry groups was 46.02. The frequency rate was maximum for support industry group and minimum for primary industry group. The frequency rate of 34.83 for the secondary industries is below the industry average.

11. The low frequency rates for primary industries could be due to their adherence to the industry safety codes and requirements as per the SABIC regulations. The other factors, which contribute to the low frequency rate, are mandatory separate safety department, qualified safety staff and adequate allocation of funds for safety management.

12. The condition of physical aspects of safety in primary industries is excellent. The safety level score for all the industries in this group are high, the average being 0.80. The safety level varies greatly in secondary group of industries, the average was 0.61, the maximum was 0.80 and minimum was 0.25. The safety level in

support industry group low when compared to primary and secondary. The average safety level is 0.47.

13. With the safety level scores for all industries it could be concluded that, the safety level varies with the size of the industry. Primary industries have better safety level than the secondary and support industries.

14. The correlation coefficient between the performance level (safety system) and the safety level (physical aspects) for primary industries is 0.107, for secondary industries 0.283 and for support industries is 0.194. The correlation coefficient for all the industries combined is 0.1974. This leads to conclude that there is no significant positive or negative association between the performance level and safety level. The linear relationship cannot be used to predict one variable from the other, as the strength of the association is very low.

8.2 Recommendations

Based on the data analysis and conclusions following recommendations are made:

1. The industry in Saudi Arabia should have uniform safety regulations and codes. There should be specific procedures applicable to the industrial construction in particular and construction industry in general.

2. The safety situation in Primary industries is excellent, but there is high variation in the performance levels in Secondary and Support industries, which call for some regulatory authority, which can enforce uniform regulations.

3. The study can be used to improve the situation in the areas which are lacking behind both in the safety climate and physical conditions. The values of performance level indicate the safety climate and the values of safety score indicate the physical condition of any industry.

4. The factor "Safety Meetings" has to be improved, to accomplish this the frequency should be increased and these meetings should be made more effective.

5. The secondary and support industries have to learn from the primary industries and improve their overall safety condition.

6. The industries in Jubail should be reclassified based on the size of the industry, rather than their product.

8.3 Future Research

Safety management system consists of three parts or aspects, the safety climate, physical aspects and the behavioral aspects. Two aspects of safety namely, the system and the physical aspect has been studied in this research. It is recommended that studies be carried out in the behavioral aspects of safety.

Further is recommended that, cost which is very important component of any industry and a matter of concern for all parties be studies. There is need for developing systematic ways to calculate the safety cost and to correlate the cost of accidents to the cost of safety to encourage all the large and small industries to take safety seriously.

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Appendix A: Request Letter for Participation in the Study

بسم الله الرحمن الرحيم

Ministry of Higher Education
King Fahd University of Petroleum & Minerals
COLLEGE OF ENVIRONMENTAL DESIGN
Dept. of Construction Engineering & Management

وزارة التعليم العالي
جامعة الملك فهد للبترول والمعادن
كلية تصاميم البيئة
قسم هندسة وإدارة التشييد

Dear Sir

The Department of Construction Engineering and Management at King Fahd University of Petroleum and Minerals is conducting a study titled **"Safety Assessment of Industrial Construction Projects in Saudi Arabia"**.

The purpose of the study is to identify and analyze the factors, which influence the safety performance of the industrial construction projects. The results of the study will be of great help to the industry.

For the preliminary study and general information, the team is in need of information regarding the industries, activities and their willingness. The required information for the actual study will be collected by way of checklist and administrating questionnaires.

At this point we will be happy to know a day and time, which is most convenient for your organization for the research team to conduct this study. We ensure you that the information will be held in strict confidence and used for research purpose only.

We will be glad to receive your willingness at the address below or through fax, at your earliest convenience. Your cooperation will be of immense help for the research.

Should you have any queries regarding the study, please feel free to contact the undersigned.

Thanking you in anticipation.

Regards,

Dr. Osama Ahmed Jannadi
Dean of Graduate Studies &
Research Advisor
Phone: 860-2800
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بسم الله الرحمن الرحيم

Ministry of Higher Education

King Fahd University of Petroleum & Minerals

COLLEGE OF ENVIRONMENTAL DESIGN

Dept. of Construction Engineering & Management

وزارة التعليم العالي

جامعة الملك فهد للبترول والمعادن

كليـــة تصـــاميم البيئـــة

قسم هندسة وإدارة التشييد

Study Title: "Safety Assessment of Industrial Construction Projects in Saudi Arabia"

Request for Appointment

Preferred Date:______________________________ Time:____________________

Company Name: ____

Location:____

Contact Person:__________________________________

Address:____

:____

:____

:____

Phone :____

Fax :____

NB: Include location map, if possible.

Dr. Osama Ahmed Jannadi
Dean of Graduate Studies &
Research Advisor
Phone: 860-2800
Fax. No. 860-4453
Email: jannadi@kfupm.edu.sa

Mirza Mansoor Baig

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Appendix B: Research questionnaire for Project Managers

Questionnaire
for
Project Manager/ Engineer
on
Safety Assessment
of
Industrial Construction Project

For details or information, please contact

Dr. Osama Jannadi
(860 2800), Email: jannadi@kfupm.edu.sa
Mirza Mansoor Baig
(860 3275), Email: mbaig@kfupm.edu.sa

Construction Engineering & Management Department
King Fahd University of Petroleum & Minerals
Dhahran, Saudi Arabia

Date and time: ____________________ **Serial Number:** ______

Please write or check the most appropriate answer for the following questions:

General Information:

1. Name of your organization (optional):____
2. Major activities of your organization: ____
3. What is the size of your company (No. of employees) ?
   ❑ <100 ❑ 101-200 ❑ 201-500 ❑ over 500
4. Year of Establishment: _______________
5. What is your job title? __________________________
6. How long have you worked for this company? __________
7. Whom do you report to? ____________________________

Please check the most appropriate answer for the following questions:

Administrative	Always	Mostly	Sometimes	Rarely	Never
Does your firm use a safety program or manual?	❑	❑	❑	❑	❑
Does you firm have a safety professional?	❑	❑	❑	❑	❑
Does your firm have a separate safety department?	❑	❑	❑	❑	❑
Do employees participate in developing safety program?	❑	❑	❑	❑	❑
Management Support	**Always**	**Mostly**	**Sometimes**	**Rarely**	**Never**
Does your top management is concerned about safety?	❑	❑	❑	❑	❑
Does your firm allocate costs for accidents/injuries?	❑	❑	❑	❑	❑
Does your firm provide safety awards?	❑	❑	❑	❑	❑
Planning Meetings	**Always**	**Mostly**	**Sometimes**	**Rarely**	**Never**
Do you conduct regular meetings to plan for safety?	❑	❑	❑	❑	❑
Do you communicate with you subordinates with regards to safety?	❑	❑	❑	❑	❑
Do personnel from top management attend these meetings?	❑	❑	❑	❑	❑
Management Safety Policy	**Always**	**Mostly**	**Sometimes**	**Rarely**	**Never**
Does management identify a need for company safety policy?	❑	❑	❑	❑	❑
Does this policy include protection of employees and others?	❑	❑	❑	❑	❑
Does this policy include expectation of managers & employees?	❑	❑	❑	❑	❑
Does this policy include general statement in response to accident?	❑	❑	❑	❑	❑
Does management communicate this policy to all employees?	❑	❑	❑	❑	❑
Does your professionals ensure enforcement of rules?	❑	❑	❑	❑	❑

General Perception

The major reasons of accident on site are that the **management** are lacking in

❑ Safety staff ❑ Commitment ❑ Organization culture ❑ Safety Policy ❑ Training

The major reasons of accidents on site are that the **workers** are short of : Safety .....

❑ Equipment ❑ Training ❑ Working instruction ❑ Organization culture ❑ Motivation

In your opinion, who should be responsible for industrial accidents during construction on site ?

❑ Worker ❑ Safety Officer ❑ Management ❑ Government ❑ Engineers ❑ Others____________

What is your suggested expenses for safety management in terms of contract cost in a construction project.

❑ 0.5% ❑ 1% ❑ 2-3% ❑ >3% ❑ Depends

Implementation of Total Quality Management in the construction industry can reduce accidents.

❑ Strongly Agree ❑ Agree ❑ Disagree ❑ Strongly Disagree ❑

Appendix C: Research Questionnaire for Safety Professionals

Questionnaire
for
Safety Engineer/Professional
on
Safety Assessment
of
Industrial Construction Project

For details or information, please contact

Dr. Osama Jannadi
(860 2800), Email: jannadi@kfupm.edu.sa

Mirza Mansoor Baig
(860 3275), Email: mbaig@kfupm.edu.sa

Construction Engineering & Management Department
King Fahd University of Petroleum & Minerals
Dhahran, Saudi Arabia.

Date and time:______________________ **Serial Number:** __________
Please write or check the most appropriate answer for the following questions:

General Information:

1. What is your job title? ___________________________

2. How long have you worked for this company? __________

3. How long have you been in this position? ______________

4. Whom do you report to? _____________________________

Please check the most appropriate answer for the following questions:

Management Support	**Always**	**Mostly**	**Sometimes**	**Rarely**	**Never**
Does management give you adequate support & resources?	❑	❑	❑	❑	❑
Is your performance evaluated?	❑	❑	❑	❑	❑
Safety Meetings	**Always**	**Mostly**	**Sometimes**	**Rarely**	**Never**
Do you have toolbox meetings on site?	❑	❑	❑	❑	❑
Does top management personnel attend these meetings?	❑	❑	❑	❑	❑
Are unscheduled meetings called when the need arises	❑	❑	❑	❑	❑
Do members attend meetings regularly?	❑	❑	❑	❑	❑
Inspection and Investigation	**Always**	**Mostly**	**Sometimes**	**Rarely**	**Never**
Does your firm conduct safety inspection?	❑	❑	❑	❑	❑
Does your firm document unsafe conditions and hazards?	❑	❑	❑	❑	❑
Does your firm take corrective measures for unsafe conditions?	❑	❑	❑	❑	❑
Does the inspectors interview the workers when investigating?	❑	❑	❑	❑	❑
Safety Training	**Always**	**Mostly**	**Sometimes**	**Rarely**	**Never**
Does your firm provide safety orientation to new employees?	❑	❑	❑	❑	❑
Does your firm gives safety training to all employees?	❑	❑	❑	❑	❑
Do you check whether employees have adequate training?	❑	❑	❑	❑	❑
Record keeping	**Always**	**Mostly**	**Sometimes**	**Rarely**	**Never**
Does the firm keep record of injuries and illness?	❑	❑	❑	❑	❑
Are records checked for accuracy?	❑	❑	❑	❑	❑
Are accident statistics analyzed to determine trends?	❑	❑	❑	❑	❑
Are records easily accessible by those with legitimate interest?	❑	❑	❑	❑	❑
Medical Facilities and Welfare	**Always**	**Mostly**	**Sometimes**	**Rarely**	**Never**
Are there adequate facilities for first aid treatment?	❑	❑	❑	❑	❑
Are sufficient persons trained to provide first aid?	❑	❑	❑	❑	❑
Are there arrangements for medical advice?	❑	❑	❑	❑	❑
Does management insist that the injured seek medical attention?	❑	❑	❑	❑	❑
Are the medical records properly kept?	❑	❑	❑	❑	❑
General Perception	**SA***	**AG***	**DA***	**SD***	**DK***
The funds allotted for safety are adequate	❑	❑	❑	❑	❑
The cause of accidents is that the workers lack safety knowledge	❑	❑	❑	❑	❑
You have knowledge of the current Safety Regulations	❑	❑	❑	❑	❑
The current Safety Regulations are adequate	❑	❑	❑	❑	❑
Safety personnel must have knowledge of construction technology.	❑	❑	❑	❑	❑

Accidents/Injuries Data

Average number of men on the payroll ______________________

Man-hour worked last year ______________________

Number of Record able injuries last year ______________________

Number of Lost time injuries last year ______________________

Appendix D: Walkthrough Inspection Checklist

Safety Assessment Form

Firm: ______________________________ **Type:** _________________________ **S.No:** _______
No. of Working Days / Week: _________ **Working Hours:** ________________ **Date/Time:**_______________

		Yes	No	N/A
Administration	Emergency Numbers/Contacts Posted			
	Hazard Communication Program			
	Daily/Weekly Safety Meetings Held			
Housekeeping	Work Areas Orderly			
	Adequate Lighting			
	Handwashing/Toilet Facilities			
	Passageway & Walkways Clear			
	Clean Eating/Drinking Area			
Fire Prevention	Fire Extinguishers Available			
	Correct Extinguishers for Job			
	No Smoking Posted & Enforced			
Electrical / Utility	Electrical Hazards Posted			
	Drop Cords Protected			
	Underground Electrical Lines Staked			
	Lockout Procedures Utilized			
	Access to Breaker Box Clear			
	Underground Gas Lines Staked			
Hand Tools	Hand Tools in Good Working Condition			
	Cords in Good Condition			
	All Mechanical Safeguards in Use			
	Proper Tools Utilized for Each Job			
	Tools Grounded or Double Insulated			
Heavy Equipment	Operation Manuals Available			
	Brakes, Lights, Signals, & Alarms Operative			
	Wheels Choked when Necessary			
	Seat Belts Worn			
	Daily Inspections Documented			
Barricades	Site Fenced			
	Roadways & Sidewalks Protected			
	Floor Openings Planked Or Barricaded			
	Access/Traffic Controlled			

		Yes	No	N/A
Material Storage	Material Properly Stored/Stacked			
	Dust Protection Adequate			
	Loads Lifted Correctly			
Excavation	Shoring Proper for Soil & Depth			
	Adjacent Structures Properly Shored			
	Necessary Ladders Provided			
	Excavation Barricaded			
	Spoil Setback at Least 2 Feet			
	Equipment Away from Edge			
Ladders	Ladders in Good Condition			
	Side-Rails Extend 36" above Landing			
	Proper for Job & Secure			
	Ladders Fully Open when in Use			
Scaffolding	Equipment in Good Condition			
	Scaffold Is Tied to Structure			
	Guardrails, Top, Mid, Toe Boards in Place			
	Connections Sound & Secure			
	Planking Cleats n Place			
	Worker Protection from Falling Objects			
Welding & Cutting	Screen & Shields in Place			
	Electrical Equipment Grounded			
	Compressed Gas Cylinders Secure/Upright			
	Proper Personnel Protection Utilized			
	Fire Extinguishers Immediately Available			
	Welding Cables in Good Condition			
P P Equipment	Hardhats Worn			
	Gloves Available			
	Steel Toe Footwear			
	Eye Protection Utilized			
	Hearing Protection Utilized			
	Safety Belts & Lanyards Utilized			
	Respirators & Masks Utilized			

Appendix E: Activity Standards Measurement Techniques, A-D

Activity Standards Measurement Technique (Petersen, 1989), A

ACTIVITY STANDARDS					
A. ORGANIZATION & ADMINISTRATION	Activity	Poor	Fair	Good	Excellent
1	Statement of policy, responsibilities assigned.	No statement of Loss Control policy. Responsibility and accountability not assigned.	A general understanding of Loss · Control, responsibility and account-ability, but not written.	Loss Control Policy and responsibilities written and distributed to supervisors.	In addition to "Good" Loss Control Policy is reviewed annually and is posted. Responsibility is emphasized in supervisory performance evaluations.
2	Safe operating procedures (SOP's).	No written SOP's	Written SOP's for some, but not all hazardous operations	Written SOP's for all hazardous operations.	All hazardous operations covered by a procedure, posted at the job location, with an annual documented review to determine adequacy.
3	Employee selection and placement.	Only pre-employment physical examination given.	In addition, an aptitude test is administered to new employees.	In addition to "Fair" new employees' past safety record is considered in their employment.	In addition to "Good": when employees are considered for promotion, their safety attitude and record is considered.
4	Emergency and disaster control plans.	No plan or procedures.	Verbal understanding on emergency procedures.	Written plan outlining the minimum requirements.	All types of emergencies covered with written procedures. Responsibilities are defined with back up personnel provisions.
5	Direct management involvement.	No measurable activity.	Follow-up on accident problems.	In addition to "Fair" management reviews all injury and property damage reports and holds supervision accountable for verifying firm corrective measures.	In addition to "Good" reviews all investigation reports. Loss Control problems are treated as other operational problems in staff meeting.
6	Plant safety rules.	No written rules.	Plant safety rules have been developed and posted.	Plant safety rules are incorporated in the plant work rules.	In addition, plant work rules are firmly enforced and updated at least annually.

Activity Standards Measurement Technique (Petersen, 1989), B

ACTIVITY STANDARDS					
B. INDUSTRIAL HAZARD CONTROL					
	Activity	**Poor**	**Fair**	**Good**	**Excellent**
1	House-keeping & storage of materials, etc.	Housekeeping is generally poor. Raw material items being processed and finished materials are poorly stored.	Housekeeping is fair. Some attempts to adequately store materials are being made.	Housekeeping and storage of materials are orderly. Heavy and bulky objects well stored out of aisles, etc.	Housekeeping and storage of materials are ideally controlled.
2	Machine-guarding.	Little attempt is made to control hazardous points of machinery.	Partial, but inadequate or ineffective, attempts at control are in evidence.	There is evidence of control which meets applicable Federal and State requirements but improvement may still be made.	Machine hazards are effectively controlled to the extent that injury is unlikely. Safety of operator is given prime consideration at time of process design.
3	General area guarding.	Little attempt is made to control such hazards as unprotected floor openings, slippery or defective floors, stairway surfaces, inadequate illuminations, etc.	Partial, but inadequate or ineffective maintenance.	There is evidence of control which meets applicable Federal and State requirements - but further improvement may still be made.	These hazards are effectively controlled to the extent that injury is unlikely.
4	Maintenance of equipment, guards, hand-tools, etc.	No systematic program of maintaining guards, handtools, controls and other safety features of equipment, etc.	Partial, but inadequate or effective maint-enance.	Maintenance program for equipment and safety features are adequate. Electrical hand-tools are tested and inspected before issuance, and on a routine basis.	In addition to "Good" a preventive maintenance system is programmed for hazardous equipment and devices. Safety report files and safety department consulted when abnormal conditions are found.
5	Material handling hand and mechanized.	Little attempt is made to minimize possibility of injury from the handling of materials.	Partial but inadequate or ineffective attempts at control are in evidence.	Loads are limited as to size and shape for handling by hand, and mechanization is provided for heavy or bulky loads.	In addition to controls for both hand and mechanized handling. Adequate measures prevail to prevent conflict between other workers and material being moved.
6	Personal protective equipment, adequacy and use.	Proper equipment not provided or is not adequate for specific hazards.	Partial but inadequate or ineffective provision, distribution and use of personal protective equipment.	Proper equipment is provided. Equipment identified for special hazards, distribution of equipment is controlled by supervisors. Employee is required to use protective equipment.	Equipment provided complies with standards. Close control maintained by supervision. Use of safety equipment recognized as an employment requirement. Injury record bears this out.

Activity Standards Measurement Technique (Petersen, 1989), C

ACTIVITY STANDARDS					
C. FIRE CONTROL AND INDUSTRIAL HYGIENE					
	Activity	Poor	Fair	Good	Excellent
1	Chemical hazard control references.	No knowledge or use of reference data.	Data available and used by Foreman when needed.	In addition to "Fair" additional standards have been requested when necessary.	Data posted and followed where needed. Additional standards have been promulgated, reviewed with employees involved and posted.
2	Flammable and explosive materials control.	Storage facilities do not meet fire regulations. Containers do not carry name of contents. Approved dispensing equipment not used. Excessive quantities permitted in manufacturing areas.	Some storage facilities meet minimum fire regulations. Most containers carry name of contents. Some approved dispensing equipment in use.	Storage facilities meet minimum fire regulations. Most containers carry name of contents. Approved equipment generally is used. Supply at work areas is limited to one day requirements, containers are kept in approved storage cabinets.	In addition to "Good" storage facilities exceed the minimum fire regulations and containers are always labeled. A storage policy is in evidence relative to the control of the handling, storage and use of flammable materials.
3	Ventilation fumes, smoke and dust control.	Ventilation rates are below industrial hygiene standards in areas where there is an industrial hygiene exposure.	Ventilation rates in exposures areas meet minimum standards.	In addition to "Fair" ventilation rates are periodically measured, recorded and maintained at approved levels.	In addition to "Good" equipment is properly selected and maintained close to maximum efficiency.
4	Skin contamination control.	Little attempt at control or elimination of skin irritation exposures.	Partial, but incomplete program for protecting workers. First aid reports on skin problems are followed up on an individual basis for determination of cause.	The majority of workmen in structured concerning skin-irritating materials. Workmen provided with approved personal protective equipment or devices.	All workmen informed about skin-irritating materials. Workmen in all cases provided with approved personal protective equipment or devices.
5	Fire control measured.	Do not meet minimum insurance or municipal requirements.	Meets minimum requirements.	In addition to "Fair" additional fire hoses and/or extinguishers are provided. Welding permits issued. Extinguishers on all welding carts.	In addition to "Good" a fire crew trained in emergency procedures and in the use of the fighting equipment..

Activity Standards Measurement Technique (Petersen, 1989), D

	Activity	Poor	Fair	Good	Excellent
D. SUPERVISORY PARTICIPATION, MOTIVATION AND TRAINING					
6	Safety promotion and publicity.	Bulletin-board posters are considered the primary means for safety promotion.	Additional safety displays, demonstrations, films are used infrequently	Safety displays, demonstrations, are used on regular basis	Special display cabinets, windows, etc. are provided. Displays are used regularly and are keyed to special themes.
E. ACCIDENT INVESTIGATION, STATISTICS AND REPORTING PROCEDURES					
1.	Accident investigation by line personnel.	No accident investigation made by line supervision.	Line supervision makes investigations of only medical injuries.	Line supervision makes complete and effective investigations of all accidents, the cause is determined, corrective measures initiated immediately with a completion date firmly established.	In addition to items covered under "Good" investigation is made of every accident within 24 hours of occurrence. Reports are reviewed by the department manager and plant manager.
2	Accident cause and injury location analysis and statistics.	No analysis of disabling and medical cases to identify prevalent causes of accidents and locations where they occur.	Effective analysis by both cause and location maintained on medical and first aid cases.	In addition to effective accident analysis, results are used to pinpoint accident causes so accident prevention objectives can be established.	Accident causes and injuries are graphically illustrated to develop the trends and evaluate performance. Management is kept informed on status.
3.	Investigation of property damage.	No program.	Verbal requirement or general practice to inquire about property damage accidents.	Written requirement that all property damage accidents of $50 and more will be investigated.	In addition, management requires a vigorous effort on all property damage accidents.
4.	Proper reporting of accidents and contact with carrier.	Accident reporting procedures are inadequate.	Accidents are correctly reported on a timely basis.	In addition to "Fair" accident records are maintained for analysis purposes.	In addition to "Good" there is a close liaison with the insurance carrier.

Rating Form (Petersen, 1989)

RATING FORM

A. ORGANIZATION & ADMINISTRATION

		Poor	Fair	Good	Excellent	Comments
1.	Statement of policy, responsibilities assigned.	0	5	15	20	
2.	Safe operating procedures (SOP's)	0	2	15	17	
3.	Employee selection and placement	0	2	15	12	
4.	Emergency and disaster control planning.	0	5	15	18	
5.	Direct management involvement.	0	10	20	25	
6.	Plant safety rules.	0	2	5	8	

Total value of circle numbers ____ + _____ + _____ + ____ x.20 Rating

B. INDUSTRIAL HAZARD CONTROL

		Poor	Fair	Good	Excellent	Comments
1.	Housekeeping - storage of materials.	0	4	8	10	
2.	Machine-guarding.	0	5	16	20	
3.	General area guarding	0	5	16	20	
4.	Maintenance of equipment, guards, hand tools, etc.	0	5	16	20	
5.	Materials' handling - hand, and mechanized	0	3	8	10	
6.	Personal protective equipment adequacy and use.	0	4	16	20	

Rating Form (Petersen, 1989) (Continue

Total value of circle numbers ____ + _____ + _____ + ____ x.20 Rating

C. FIRE CONTROL & INDUSTRIAL HYGIENE

		Poor	Fair	Good	Excellent	Comments
1.	Chemical hazards control references	0	6	17	20	
2.	Flammable and explosive materials' control	0	2	15	17	
3.	Ventilation - fumes, smoke and dust control	0	2	8	10	
4.	Skin contamination control	0	3	10	15	
5.	Fire control measure	0	2	8	10	
6.	Waste - trash collection and disposal air/water pollution	0	7	20	25	
		—	—	——	____	x .20 Rating __

D. SUPERVISOR PARTICIPATION, MOTIVATION & TRAINING

1.	Line supervisor safety training	0	10	22	25
2.	Indoctrination of new employee	0	1	5	10
3.	Job hazard analysis	0	2	8	10
4.	Training for specialized operations	0	2	7	10
5.	Internal self-inspection	0	5	14	10
6.	Safety promotion and publicity	0	1	4	15
7.	Employee/supervisor contact and communication	0	5	20	25
		___ +	__ +	___ +	__ x.20 Rating

E. ACCIDENT INVESTIGATION, STATISTICS AND REPORTING PROCEDURES

1.	Accident investigation by line supervisor	0	10	32	40
2.	Accident cause and injury location analysis and statistics	0	3	8	10
3.	Investigation of property damage	0	10	32	40
4.	Proper reporting of accident and contact with carrier	0	3	8	10

Total value of circled number __ + __ + ___ + ___ .20 Rating

Summary Sheet (Petersen, 1989)

SUMMARY

		RATING
A.	Organization & Administration	________
B.	Industrial & Hazard Control	________
C.	Fire Control & Industrial Hygiene	________
D.	Supervisory Participation, Motivation & Training	________
E.	Accident Investigation Statistics & Reporting Procedures	________
	TOTAL RATING	________

Appendix F: Master Development and Evaluation Grid

Profiling grid (Petersen, 1989),

#	Item Description	0 %	10 %	20 %	30 %	40 %	50 %	60 %	70 %	80 %	90 %	100 %
1	Management Involvement (Policy)											
2	Total Loss Control Manager (Professional Competence)											
3	Total Loss Control (Manager Technical Experience)											
4	Total Loss Control (Manager Aptitude and Talents)											
5	Accident Investigations (in depth)											
6	Plants and Facility Inspection.											
7	Laws, Policies Standards.											
8	Group Meetings (Management).											
9	Safety Committee Meetings.											
10	General Promotion (Posters, banners signs.)											
11	Personal Protection.											
12	Supervisory Training.											
13	Employee Training.											
14	Selection and Employment Procedures.											
15	Management Involvement (Policy)											

Continued

Key areas which call for priority action

Key areas which call for planning

Key areas were further action is not urgent

Profiling grid (Petersen, 1989),

#	Item Description	0 %	10 %	20 %	30 %	40 %	50 %	60 %	70 %	80 %	90 %	100 %
16	Occupational Health and Hygiene.											
17	Fire Prevention and Loss Control.											
18	Total Accident Control Accident Analysis.											
19	Personal Communications.											
20	Total Job Safety Analysis.											
21	Total Job Observations.											
22	Records and Statistics (National and Local Laws).											
23	Emergency Care (First Aid).											
24	Product or Service Liability.											
25	Off-the-Job Safety (Road and Home).											
26	Accident Recall and Analysis.											
27	Transport (including sales and management transport).											
28	Security (Program).											
29	Economic Applications.											
30	Pollution and Disaster Control.											

Vitae

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- Received Bachelor of Engineering (BE) degree in Civil Engineering from Osmania University, Hyderabad, India.

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